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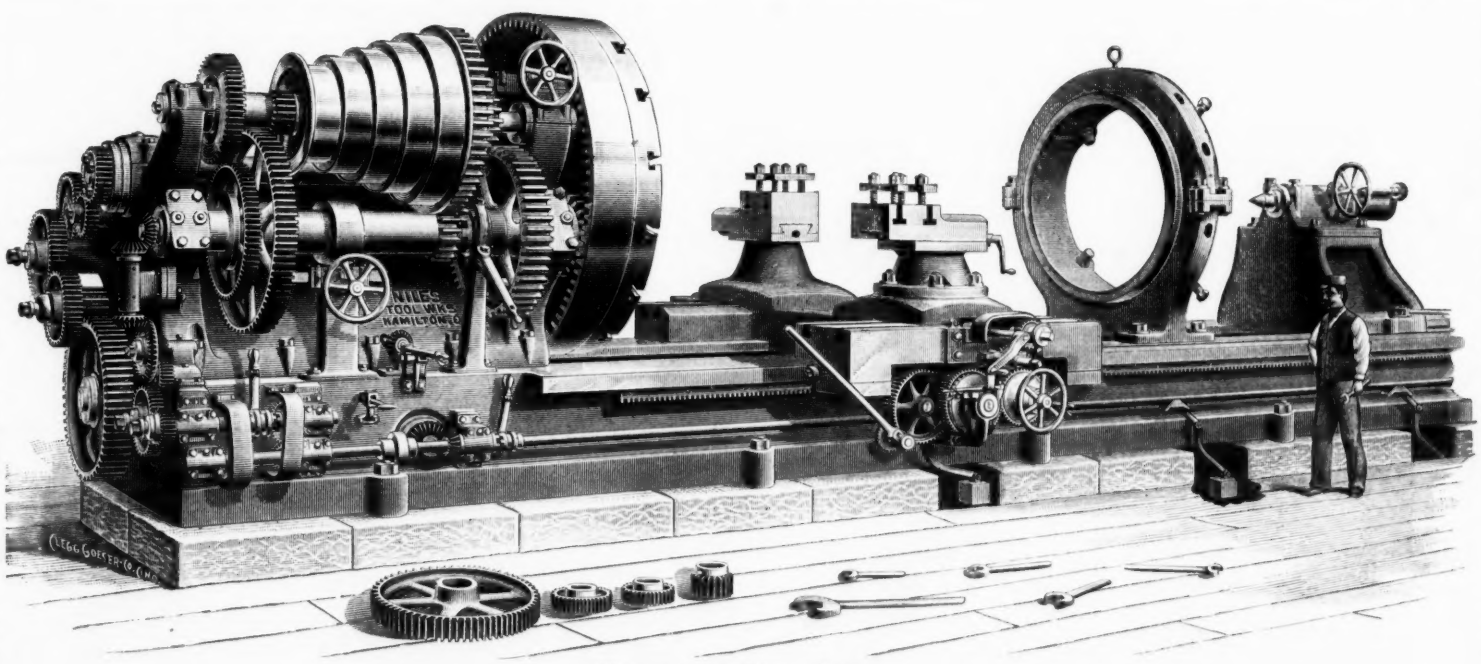
Ninety-inch Forge Lathe.

The engraving on this page is of an extra heavy and powerful 90″ lathe built by the Niles Tool Works at Hamilton, O., and called a "forge lathe" from the circumstance that this type of lathe was first designed for rough turning and finishing heavy forgings, on which usually very heavy and very irregular cuts are to be taken. The particular lathe shown was designed especially for boring and turning steel ingots used in the construction of heavy ordnance for the United States government.

The lathe swings over the ways 91″, over the carriage 70″, and takes between centers 45 feet, the bed being 60 feet 6″ long, arranged with triple shears, tied together by a continuous web and with heavy cross girts. The weight of the bed alone is 110,000 pounds.



NINETY-INCH FORGE LATHE.

The main spindle is a steel forging with front bearing 16″ diameter, 24″ long. The service this tool is required to do in boring ingots imposes very unusual strains on the spindle, and in order to take the thrust the spindle is provided with seven thrust collars, enabling it to withstand an end pressure of 200,000 pounds. The area of the collars is sufficient to reduce the pressure to 500 pounds per square inch.

The driving cone has five steps for 6″ belt and is so geared that there are twenty changes of speed to the face-plate.

All the gearing of the head-stock is steel (castings or forgings) cut from the solid, of heavy pitch and great strength.

The carriage, as will be seen, is heavy and substantial. It is gibbed to the bed, both outside and in, the full length, and taper gibs provided for adjustment.

There are two tool-posts, one in front with compound movement, and a plain one in the rear.

The carriage is traversed for feed and quick movement by three separate and independent movements, one being by means of the lead screw, which is 6½″ diameter, one continuous forging 60 feet 6″ long. This screw is placed in the center of the bed in a groove provided for the purpose and arranged with coverings to protect it from dirt and chips. The thrust in the lead-screw is provided for in a manner similar to the spindle by means of thrust collars.

The bronze feed-nut engaging with the lead-screw in the carriage is 36″ long, the weight of this nut being 1,200 pounds.

Provision is also made for moving the carriage independent of the lead-screw and rod gears by shaft driven from an independent counter-shaft, giving a quick traverse to the carriage of 10 feet per minute, the arrangement being such that this motion cannot be thrown in while the feed nut is engaged with the screw.

The foot-stock is secured to the bed by four bolts, engaging with "T"-slot in the bed, and it is traversed on the bed by ratchet lever operating a pinion into a rack on the bed.

The lathe is provided with steady rests, having ring bearings for sustaining heavy work. The large one will take 60″ in diameter, the load being sustained by a ring bearing having over 1,200 square inches of projected area. The lathe has sufficient strength and stiffness to carry a load between centers weighing about 60 tons, and to perform the necessary cutting operations. In the steady rests shafts or ingots weighing over 200 tons can be operated upon successfully. The lathe weighs complete 130 tons.

Columbian Exhibition Notes—XIV.

Editorial Correspondence.

An interesting exhibit of bolt-making machinery is that of the Acme Machinery Company, of Cleveland, O., this company having also developed its bolt heading machine into something like a general forging machine, while its bolt cutters have, in some instances, taken the form of machines fitted for threading screws for cotton presses or roughing out the threads for traversing and lead screws for machine tools.

The exhibit here is composed of eight machines in all, the largest and heaviest of these being what they call their 1½″ bolt heading, upsetting and forging machine, which is shown in motion, though not working, since a furnace would be required for that. This machine—a description of which we gave in our issue of March 30—has a horizontally moving plunger, which forms the head of the bolt, the die gripping the stock firmly enough to hold it for the heading operation without a back stop, the result being that the stock is gauged for length from the end that projects through the dies, and a bar can be heated for a distance of three to four feet and fed in, the machine cutting off the stock, heading it, and making a finished bolt in many cases at each stroke, this giving the further advantage that heads or upsets can be formed on rods of any length.

For square or hexagon bolt heads that require to be brought to standard size and with parallel sides, from two to three blows finishes the head. The dies being closed by a toggle joint arrangement, grip the work very powerfully, and they can be arranged to do a large proportion of the forging usually done under the drop hammer, it being necessary only to make dies suitable for the work to be done.

There is an outside shear which can be used for cutting bolts or other forgings to proper length after heading, when, for any reason, it is not advisable to use the cut-off die in the usual manner.

A large number of very interesting specimens of forgings are shown, which include the heads of monkey-wrenches, upset upon a square bar, the collars upon heavy wagon axles, also upset upon the square bar, the outer ends being afterward drawn down under the hammer to form the spindle, the eyes of pick-axes, upset ends of car truss rods, etc., these latter being upset at the ends (for threading) upon the full length rods, thus obviating the necessity for welding ends on.

An idea of the capacity of the machine and its efficiency as compared with the usual methods of doing such work may be gained from the fact that 960 of such ends have been made per day upon it.

Among the threading machines shown is one for cutting taper threads on such work as molasses or beer faucets, or on thin brass tubes, the taper being produced, not by a taper die, as usual, but by a die composed of four chasers which are straight, but are opened as the thread is cut, this opening being produced by wedges working in a sliding ring upon the head; the taper of the wedges being made to correspond to the taper of the thread. One result of this method is that taper threads can be cut upon very thin brass tubes without deformation of the tubes in the least.

There is also a special 2″ threading machine in which a lead-screw is used for feeding the blank to the die, the machine being capable of some very remarkable work in finishing ordinary screws, or in roughing out the higher grades of screws such as lead screws, a hollow spindle affording a means of cutting any length. Such machines are now built to cut threads up to 6″ diameter, and of any desired pitch, their rate of work being, of course, very much more rapid than that of a lathe.

A sample thread is shown which is 1¼″ outside diameter, two threads per inch, the depth of threads being ¼″. The length of the screw is 26″, and it was finished at one cut. A novel method is employed of providing hardened and ground surfaces for the sliding parts of their die heads. The parts are cylindrical and slide one upon the other. It is not practicable to harden them all over, and so strips of hardened steel are set into the surfaces of the head and ring, these strips being like feathers, except that they do not project above the surfaces. The whole surface is then ground to size the same as though it were all hardened steel, the wheel, however, cutting a little freer in the softer metal between the strips, and thus automatically relieving the bearing between the strips, which thus slide upon each other and constitute the real bearing.

An inspection of this exhibit shows that a great deal of skilled effort has been given to the matter of producing screw threads by dies, much larger in diameter than it is usually considered possible to make in that way.

Though the principal exhibit of the Pond Machine Tool Company is in the machine shop which has been already referred to, they have in Machinery Hall proper a lathe for turning steel tired car wheels and a driving wheel lathe.

The first mentioned machine especially is something of a novelty, and is shown at Fig. 73, page 2. The central worm-wheel is driven by a worm below, and in this wheel is a removable piece which, when taken out, permits the axle to pass through to the position shown. The axle is then centered by means of tapered and split bushings which fit over the bearings, the outside of

these bushings fittting taper holes in the spindles. One of these bushings is seen in place upon the left-hand bearing. After these are in place and the wheels are thus centered by the bearings upon which they are to run, the independent four-jawed chucks are adjusted to support the wheels by running the jaws outward until they engage the projecting rim of the wheels, which are then driven from the face-plates inside the wheels. By this method of holding, not only are the wheels centered by the bearings, but the length of the machine is reduced, and the rigidity of the work increased. The machine is used only for returning Allen wheels that have been worn out of true or out of shape in service, and some idea of its capacity may be had from the fact that at the Pullman works, on a test, seven pairs of such wheels, 38″ diameter, badly worn, were turned to shape and uniform diameter in 10 hours, 35 minutes.

The driving wheel lathe swings 74″ over the tread and has the rear portion of the bed considerably lower than the front, thus securing with a given swing relatively low and rigid posts upon which the slide rests are carried. A double system of gearing is provided, and there is a quartering attachment, the tool representing the latest practice in machines of its class.

The space of A. Falkenau, of Philadelphia, is filled with tools that are for the most part familiar to our readers, the lathe having been illustrated and described in our issue of March 31, 1892; the Taylor tool grinder in issue of March 24, 1892, and the universal and cutter grinder in issue of June 8, '93.

Besides these there is a tablet compressing machine for the use of manufacturing chemists which resembles a punch press with automatic feed for the material to be compressed.

A new hand hoist is shown in which the crank is turned the same way (from the operator) whether hoisting the load or lowering it. There is a drum upon which the rope is wound, and this is driven by a gear wheel and pinion, the crank-shaft having two pinions between which is a double-ended sliding clutch. When this clutch is in mid-position, turning the crank has no effect upon the drum, the load being sustained by a band brake which passes around a stationary disk fixed to the frame of the machine. When moved in one direction the clutch engages the pinion that winds up the load; the other position, in engagement with the other pinion, drives a gear that simply serves to partially release the band brake and allow the load to descend. The machine is a novel one, very simple and apparently very efficient.

An exhibit which will have a familiar appearance to our readers is that of Curtis & Curtis, of Bridgeport, Conn., who show six of their pipe-threading machines, some to be driven by hand, some by power and others by either hand or power. One of the machines is belted and is shown in motion. We have illustrated and described these machines in issues of February 12 and March 26, 1891.

Pipe-threading and cutting machines of various styles and sizes, varying from ⅛″ to 8″ pipes, are shown by the Merrell Mfg. Co., of Toledo, O., some of the machines exhibited having been illustrated and described in our issues of March 3 and November 3, 1892.

In these machines, as in the Curtis & Curtis, the pipes to be cut are not rotated but are held stationary while the die, which is adjustable and opening, is rotated about the pipe.

A novel cutting off device is employed on these machines, consisting of a cutting blade with a round threaded shank at the back which fits a nut that is also a small worm wheel, this being rotated by a worm that is on the end of a small crankshaft that can readily be given any desired rate of motion as the die revolves, the holder and slide for the tool being attached to the face of the die head. Special features of the machines are quick adjustment and change of dies, these being changed for extreme range of sizes of pipe. One machine is shown apart so that its construction may be readily understood.

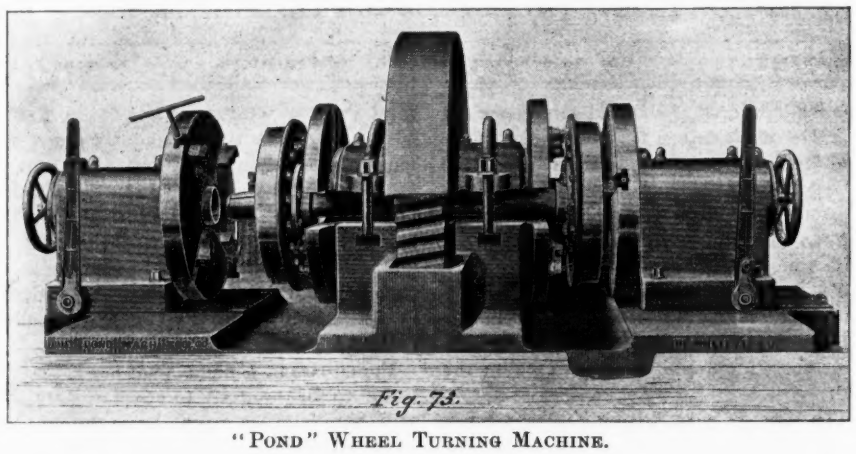


Fig. 73.

"POND" WHEEL TURNING MACHINE.

Near the extreme south end of the center aisle is to be seen the largest and heaviest machine tool in the Exhibition. This is a planer built by the Niles Tool Works, and is illustrated in Fig. 74. The planer will plane work 12 feet wide and high, 30 feet long. Its total weight is 165 tons, the platen alone, which is a single casting, weighing 35 tons. As the engraving shows, there are four heads, those on the cross rail being counterbalanced by the weight, which is attached to the chain. The side heads are carried forward even with the others; have automatic feed in any direction, and either of these heads can be taken off, the line of separation being at the swiveling plate. The head so removed is then applied to a saddle, which is fitted to the post seen at the further side of the machine, this post being fitted at bottom to a side extension, which is bolted to either the side of the bed, there being on both sides of the machine a planed surface, provided with T slots, by means of which the extension is bolted fast. Automatic feed is carried to the head when in this position by means of horizontal and vertical splined shafts connected by miter gears. In the engraving the left-hand side head has been removed from the housing, and is upon the extension post.

It will be noticed that the housings are extremely massive cored or box sections, with very broad faces, the cross-rail being also very deep vertically; it also is of the box form, as are the cross-webs of the bed. The driving shafts are of steel running in brass bushings, and the gear train is composed of spur gears. Feeds are automatic in all directions for all the heads, are positive, can be operated within a very small movement of the table, and consume no power except at the moment of feeding. Lubrication of the ways is provided for by conical rollers sunk within pockets filled with oil. In machines of this size it would not, of course, do to have the heads free to turn when the clamping bolts are loosened, and they would be too heavy to handle in the ordinary manner; they are, therefore, set at the desired angle by means of worm teeth cut upon the outer edge of the swiveling plate.

The extra shaft passing through the rail is for working eccentrics, by which the tools are raised to clear the work on the back stroke.

The General Electric Co. has, at Lynn, Mass., a planer of the same size by the same builders, and this one is to go to the Lake Erie Engineering Co.'s works at Buffalo. The only planer in America that will handle larger work is an old style machine which is at the Charleston Navy Yard.

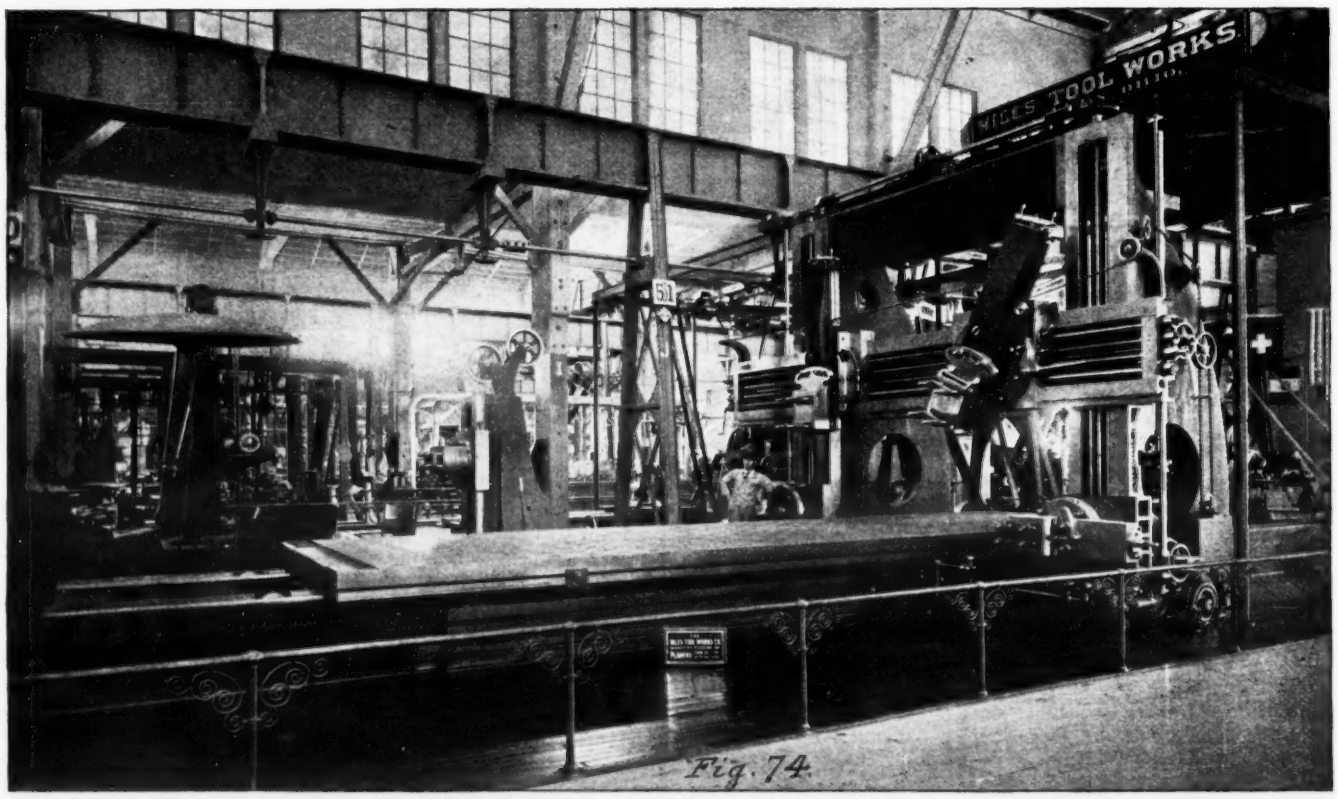


Fig. 74.

THE LARGEST MACHINE TOOL IN THE EXHIBITION.

Besides the planer there is one of the well-known "Niles" boring and turning mills of moderate size, swinging 73″, and taking 36″ under the cross-rail. The peculiar features of this machine, its universal chain counterbalance, which has evidently been applied to the planer; its tool bars of octagonal section, having all the surfaces scraped to a bearing; the arrangement for letting the table rest upon an annular bearing near its outer edge when doing heavy work; the adjustment for the main spindle by which it is kept central, make it a notable tool, aside from its evident great power and rigidity.

There is also a horizontal boring, drilling and milling machine of the type which has recently been introduced in this country, and which consists essentially of a large platen, upon which is an upright or post carrying a vertically moving saddle, upon which is the horizontal spindle, there being also an outboard bearing for the bar, which is supported by a second post. The machine shown will bore or drill within, or mill off, any surface up to 9 feet long and 6 feet high, the main column being 10 feet 6″ high. The spindle, of hammered steel, is 4½″ diameter, and has a continuous endwise traverse of 4 feet; it turns in either direction, and has eight different rates of power feed. The movements of the column upon the bed and of the saddle upon the columns are by power feed at six different rates for milling, and there are twelve different speeds for the spindle, which has ample power to bore up to 24″ holes.

A 63″ heavy "forge lathe" is shown, the name for this tool being derived from the fact that the first of its type was designed especially for finishing heavy forgings, where the work is of the severest character.

The lathe swings 47½″ over the centers, and takes 20 feet between centers. The cone is mounted upon an independent steel shaft, which has a steel pinion gearing into an internal gear on the face-plate. There are fifteen changes of speed; the main spindle is 10″ diameter at the front bearing, which is 15″ long. The carriage is 63″ long, fitted and gibbed to the bed its entire length. Foot-stock is held by pawl engaging with rack cast in center of bed, this, with the four binding bolts, making an accidental slip impossible. The set-over slide is independently held by four bolts, so that it can be adjusted to turn taper while heavy work is upon the centers without loosening the foot-stock from the bed.

A turret screw-machine for making screws from ⅜ to 1½″ diameter completes the exhibit. This machine has automatic rotation of turret; carriage provided with automatic feed and a clutch for throwing the back gears in or out of action, which is a friction clutch for the cone pulley, and a positive locking clutch for the main driving gear, where the heaviest work is done, the result of the combination being smoothness of action with ample driving power.

The exhibit forms one of the main attractions of Machinery Hall.

One of the most novel, though at the same time simple grinding machines to be seen in the exhibition is that shown by Charles H. Besley & Co., of Chicago. This machine is much the same as the familiar emery grinder, except that in place of the

usual emery wheels there are, mounted upon the spindle, disks of cast iron which are turned and faced true, and upon their outer flat faces have shallow spiral grooves formed something in the style of those seen in a scroll chuck. Upon the face so prepared emery paper or cloth is glued and pressed tight while drying, the result being a grinding wheel which is wonderfully and surprisingly efficient, the grooves though covered by the emery paper seeming to add very much to its cutting qualities.

Samples of small pulleys are shown which have been ground upon their outer faces by these machines, the pulley being placed upon an arbor which is laid in suitable Vs provided for such work.

Besides this there are rests suitable for other work; one of these at least being arranged to swing across the grinding face in a straight line, thus producing a plane surface upon the tool or whatever is being ground.

Punches, shears, drawing and embossing, presses, and nearly all other kinds of sheet-metal working machines are shown in operation by the Ferracute Machine Company, of Bridgeton, N. J., most of the machinery in this exhibit being from new designs, which, besides being "functional," are very neat in appearance.

One of the first machines noticed is a combined horning and wiring machine, the horn, which is used in seaming operations, being easily removed when the press is to be used for wiring; there being below the horn the knee, which is adjustable vertically and can be bolted fast to the frame at any height and having upon it a swinging bolster in which the wiring die is placed. The press can also be used as a cutting press, its combination features making it especially well adapted to places where there is a limited amount of work to do—not enough to keep one or more machines always employed upon a single operation.

The drawing press shown has its blank holder worked by cams on the crank-shaft, the arrangement being such that the vertical adjustment of the blank holder is always square with the die, or in other words it cannot be itself adjusted to bear harder or less hard upon one side of the die. A new plan is adopted for this adjustment, and the die itself is raised slightly at one side or the other by wedges which are forced under the bolster by suitably arranged screws. The actual amount of movement required to make such an adjustment is so very slight that the springing thus effected is found to be ample for the purpose, while it is believed that a more substantial construction is thus obtained than is possible where a separate adjustment is provided in the blank holder.

Improved spinning lathes are shown also, and the embossing press is at work producing samples of work in aluminum, the embossed portion being a representation of Machinery Hall.

The exhibit of the Millers Falls Company, of Millers Falls, Mass., consists mainly of small tools for which they have made themselves famous, but includes also their power hack saw, which, though the man in charge of the exhibit told me that the dealers declined to handle it at all when it first came out, has now become a standard tool in most machine shops, having been introduced directly to machinists when the dealers concluded there was "nothing in it," the machinists having no difficulty in seeing that there was something in it.

Testing machines for almost every imaginable purpose are shown by the Riehlé Bros. Testing Machine Co., of Philadelphia, Pa., their exhibit including twelve testing machines, ranging in capacity from the simplest and smallest foundry test machine, or cloth testing machine, to what is claimed to be the largest vertical testing machine yet constructed, this being capable of putting upon a specimen a compression, a tensile, or a transverse strain of 150 tons.

This machine has an adjustable upper head, which is moved by power to suit the length of the specimen, after which the test is made by the movement of the lower head only, thus making it convenient to test short specimens.

Tests are constantly being made with the machine, which seems to be under perfect control. The screw beam is arranged with electric contact, so that it is automatic in its operation.

Next to this machine in power is a horizontal car coupler, link and chain testing machine, in which the strain is applied by a hydraulic pump, the system of levers and scale beam being employed to indicate its amount. Specimens of any desired length can be tested to a strain of 200,000 pounds.

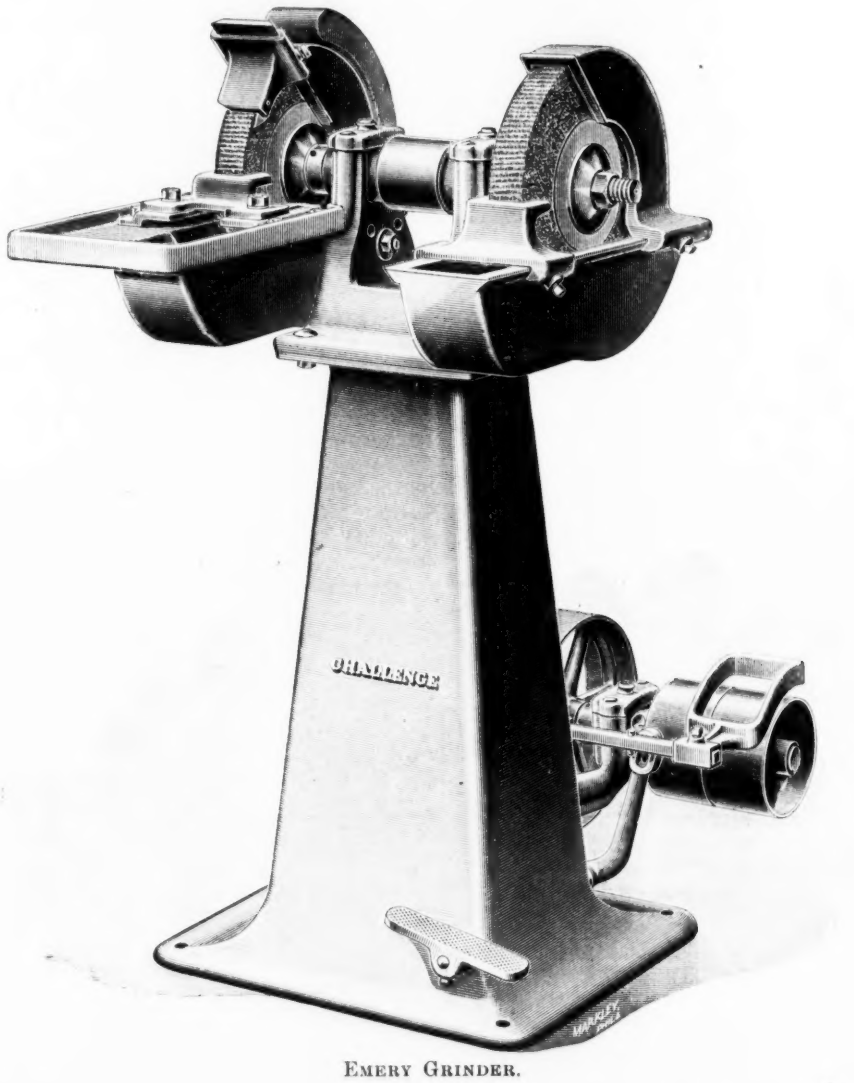
A machine of equal power is a vertical machine similar to the first mentioned, but having its upper head fixed.

An entirely new machine is one of 100,000 pounds capacity (vertical), which has an electric, automatic beam with autographic attachment for recording strains. As the strain is being exerted upon the specimen, the poise moves out and keeps the beam in equipoise until the specimen breaks, the poise then remaining in its place on the beam, so that the reading can be noted at leisure. It is then automatically returned to zero by a reversing gear.

There is also a spring testing machine, capable of exerting a force of 80,000 pounds, this machine also making use of a hydraulic pump. Torsional and cement testing machines are shown also, and the smallest machine is intended for testing cloth, this, for obvious reasons, being arranged for tensile strains only, which it will exert up to 500 pounds.

A number of interesting and ingenious extensometers are shown, including one of unusual interest from the fact that it is the identical instrument used by Col. W. H. Paine some years ago at the Niagara Suspension Bridge, which had been condemned, but was saved by Colonel Paine's report, which was based upon the indications of this instrument, showing that the cables were subjected to a strain well within their elastic limit, even when the bridge was loaded with heavy engines from end to end. The same instrument was used for testing the wires that constitute the cables of the New York and Brooklyn Bridge.

F. J. M.

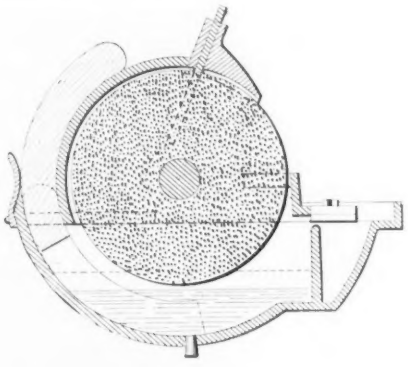


EMERY GRINDER.

A New Emery Grinder.

We illustrate with this a new emery grinder which is so arranged that if desired one of the wheels may be run dry and the other with water.

The device encasing the wheel on the right is for dry grinding, and that on the left is for wet grinding, water being used to prevent drawing the temper of tools when being ground.



EMERY-WHEEL DRESSER.

These wheel guards, besides serving as a protection to the workman in case of accident to the wheel, are so arranged as to catch and retain all the dust and grindings without the necessity for employing exhaust fans.

The guard for wet grinding differs from that for dry grinding, in having an opening at the back through which the curved piece shown in the sectional view is introduced to control the height of the water in the tank below, the amount of water thrown upon the work depending upon its height, or the depth to which the wheel enters it. The piece mentioned is held in place by a spring and can be instantly adjusted to any desired level.

By the form of hood adopted the water picked up by the wheel is thrown directly onto the work, and the hood can, by the arrangement shown, be readily adjusted to suit the wheel, as the latter wears down.

The guard for dry grinding will also hold water below which serves to catch and retain all dust and grindings. Both arrangements are provided with separate pockets in front as shown in the sectional engraving, this separate pocket being for water in which to dip tools.

The machines are built with either or both wheels wet or both dry as desired, in seven sizes suitable for wheels from 10″ to 30″ diameter, the smaller sizes being arranged to place on the bench, belting from above or below, or they are mounted upon a plain base or upon the one shown which has counter-shaft attached. In this latter arrangement the driving side of the belt passes through a hole provided for that purpose at the top of the column and down though the hollow column to the driving pulley.

It will be noticed that the faces of the wheels show transverse corrugations, the purpose of which is to prevent glazing and heating, and to increase the cutting. This is done by the double dresser shown. One end corrugates and the other end dresses to a smooth surface for fine grinding.

The machine and dresser are made by the Appleton Mfg. Co., Philadelphia, Pa.

On the Cultivation of the Inventive Capacity by the Solution of Constructive Problems.

BY LEICESTER ALLEN.

In the enumeration of solutions in which parallelism of the connecting rod is secured by slides in my last article, I overlooked a correct solution forwarded by Mr. A. L. Bach, of Syracuse, N. Y., which, however, presents nothing in principle or construction substantially different from others already described and illustrated. I made a similar oversight with reference to a solution worked out on this principle by Mr. Charles A. Wright, of Philadelphia, Pa., and one by Mr. Peter L. Adams, of West Duluth, Minn.

Coming now to the group of pantograph movements, of which Mr. McNutt's, shown in Fig 5 in the issue of July 20, is a type, there has been quite a number of variations sent in by different gentlemen; but, as these variations consist for the most in a different selection of position for the fixed pin of the pantograph system of links, I do not think it is necessary or advisable to describe and illustrate them, with the exception of a single one forwarded by Mr. H. L. Reynolds, mechanical engineer and patent attorney, of Seattle, Washington, and illustrated in Fig. 1. Before discussing Mr. Reynolds' solution, I will give the names of those who have worked out the problem correctly on the pantograph principle in the following list:

Mr. W. H. Freeman, of San Francisco, who also has sent a solution on another principle, which will be illustrated and described in a subsequent article; Mr. W. P. Tarbell, of Milford, N. H., who requests my opinion as to whether the adoption of the form of pantograph, shown in his drawing, as well as in several others, and wherein the central pivot is made the fixed fulcrum, is not an improvement upon other forms of the pantograph hitherto in use, and to whom I must reply that, except perhaps for some special uses, as the production of the movement under present consideration, I see no apparent advantage in this position over others; Mr. A. B. Cunningham, of Providence, R. I.; Mr. W. T. Sears, of Plymouth, Mass., who also has supplied other interesting solutions, reserved for a future article;

Mr. Charles L. Graves, of Bridgeport, Conn.; Mr. A. W. Kirsch-King, Superintendent of the Frazier Cycle Company, of Aurora, Ill., and Mr. Geo. W. Drake, of Cleveland, Ohio.

Fig. 1 illustrates what may be called a double-pantograph movement that renders the system of links entirely independent of any support for the fixed fulcrum, other than what is afforded by the crank-pins themselves. The movement is easily understood. A duplicate system of pantograph links is pivoted at the center to the one directly connected with the primary crank-pins, as shown at *A*, and the middle joints of the duplicate pantograph are connected to the secondary pins of return cranks shown in horizontal position in the figure. Mr. Reynolds says of this movement that "it is complicated, but will fulfill the conditions. The two sets of lazy tongs act upon the two sets of crank-pins on the return cranks. The pin *A* need not be fixed to the framework, as the two sets of levers combine to keep it in its proper place. I think this would present a queer appearance when in motion."

I regard this as being the most ingenious of all the movements yet presented, and as indicating a very high order of inventive talent. Movement is possible in either direction; the velocity ratio is 1, as required in the problem, and no support other than the cranks is required for the connection, a thing which I did not deem possible in a pantograph movement before Mr. Reynolds' solution reached me. The extreme northwest of this great country appears to lack neither commercial nor mechanical ability.

Let us now consider solutions in the class of third-crank movements, of which the solution contributed by Mr. Francis W. Clough, of Springfield, Mass., and shown in Figs. 11 and 12 in my last article is a fine type. In describing his solution, Mr. Clough appeared to regard the location of the crank-shafts as important. The solutions herewith given will show that they may be placed in other angular relations, and still be operative. This class of movements affords a variety of good, simple, mechanical devices for effecting the purpose desired.

In Fig. 2 is illustrated a movement devised by Mr. Alfred T. Brown, of Cincinnati, Ohio. With reference to the solution shown in the figure, Mr. Brown, after some complimentary remarks upon the general interest of these problems, and the particularly interesting character of problem No. 5, which we are now considering, proceeds to say: "The only requirement seems to be that there be maintained in the connecting bar a rigid self-parallelism for all positions of the stroke. This can be attained most easily, and with least loss from friction, by use of an idle disk or crank having an equal radius with both driver and driven disks, this idle wheel or crank being placed with its center in a line at right angles with the line of centers of the driver and driven disks." Mr. Brown also describes but does not send sketches of a pantograph movement, and also one in which a slide is used to secure self-parallelism of the connecting rod.

A solution, substantially the same as that of Mr. Brown, has been contributed by Mr. G. L. Hubbell, of Bridgeport, Conn. He also mentions a possible solution of the same class in which the crank centers instead of being in angular relation may be placed in line, but he does not give a sketch of such an arrangement. Mr. Baxter Aslakson, of Waynesboro, Pa., supplies this deficiency in his excellent solution illustrated in Fig. 3. *A* is the driver, *B* the driven wheel, and *C* is the idle crank or disk. It may be remarked that when the crank centers are in line, it is essential that the driver shall occupy an intermediate position between the idler and the driven disk.

Mr. James Tobin, of Brooklyn, N. Y., sends in a solution in all respects similar to that of Mr. Aslakson. Solutions substantially similar to that of Mr. Clough, published in the issue of July 20, have been received from Mr. W. K. Liggett, of Columbus, Ohio; Mr. Axel Colliander, of Chicago, Ill.; Mr. W. P. Tarbell, of Milford, N. H.; and from Mr. John W. Broadhead, of Providence, R. I

It will be seen that none of the third-crank movements yet presented avoid the use of a support on some part of the framework for the third crank-shaft. I herewith present a solution of my own, which is the one I submitted to Mr. Fred. Miller, of the AMERICAN MACHINIST'S editorial staff, before this problem was announced. Referring to the Figs. 4 and 5, *A* and *B* represent the two wheels or disks, *A* being the driver, and *S S'* their respective shafts. *W* and *W'* are the crank-pins, and *R* is the connecting rod. *C* is the idle crank, which has its bearing in the strap support *T T'*, which is fitted to and rests upon the disk *A* after the usual manner of fitting straps to eccentrics. The part *T'* of the strap has an arm *E* extending toward and meeting the disk *B* by a foot *F'*, which is fitted to the perimeter of the disk *B*, and which may be, if desired, a continuous ring or strap similar to that described for the disk *A*. It will be seen that this arrangement holds the crank centers in line, and that the rotation may take place in either direction starting at any point of the revolution. The dotted lines show the parts in one of the positions when the crank-pins are not in the line of centers of the shafts. These disks may be connected as described, and placed concentrically with the shafts of larger wheels by fitting the disks to extensions of the shafts projecting in front of the larger wheels. Another variation would be the fitting to the shafts *S S'* of a bar behind the disks, this bar having an extension with a bearing for the crank *C* in line with the centers of the shafts.

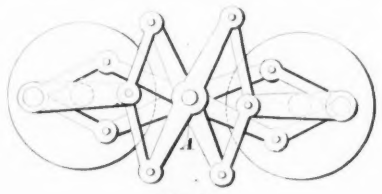


Fig. 1

Fig. 2

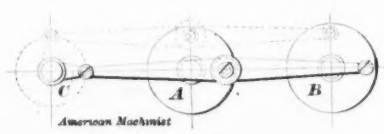


Fig. 3

Fig. 4

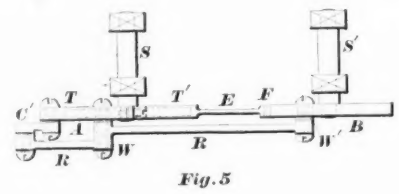


Fig. 5

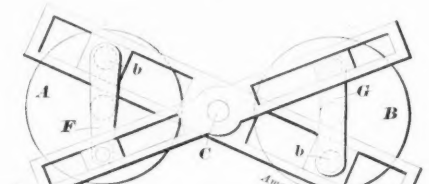


Fig. 6

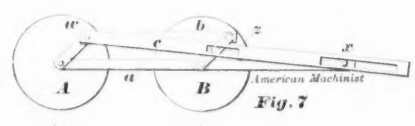


Fig. 7

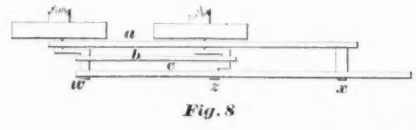


Fig. 8

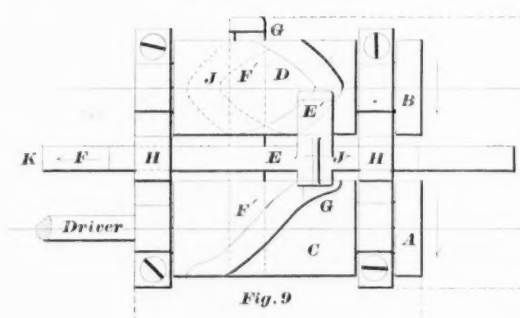


Fig. 9

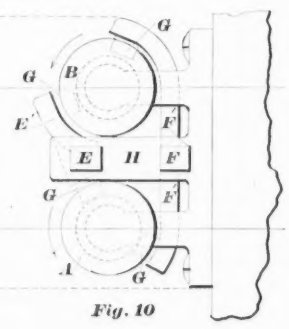


Fig. 10

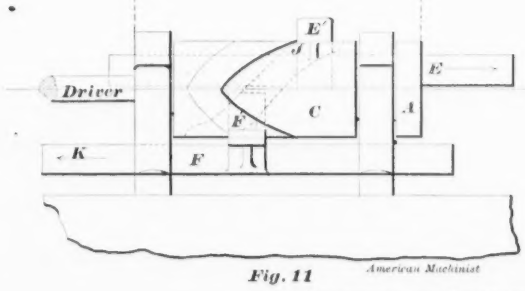


Fig. 11

SOLUTION OF PROBLEMS.

We pass now to the consideration of some solutions which cannot be classed with either of the three groups comprising the greater number of the solutions which this problem has called out. Some of these are extremely ingenious.

Mr. H. L. Reynolds, who gave us the elegant pantograph solution shown in Fig. 1, has favored us with another, no less simple and elegant, which is illustrated in Fig. 6. With reference to this solution, Mr. Reynolds writes: "This movement uses return cranks *F G*, and levers *D* and *E*, which are pivoted on the fixed pivot *C*. Blocks attached to the crank-pins slide in slots in the levers. The pivot *C* should, as for the other solution, be placed at the center of the straight line connecting the disk centers. This device gives equal velocities to the disks, reversibility, no dead center, and either wheel may be used as the driver. Eccentrics might be used instead of the return cranks; but, as the crank radius would thus be less, the angularity of the levers would be less, and there would be more nearly a dead center."

A solution involving a similar principle has been contributed by Mr. J. A. Smith, of Rockland, Maine. This solution is illustrated in Figs. 7 and 8. Mr. Smith writes: "If not too late, I would submit the inclosed solution to problem No. 5 in AMERICAN MACHINIST. As you do not seem to exclude *one* connecting rod, provided dead centers are avoided, I think the device fulfills the conditions; the velocities of *A* and *B* are the same. The crank-pin *z* has half the throw of the main cranks, and the distance from *w* to *z* is half of that from *w* to *x*. The rod *a* has no movement, being used only to support the stud *x*, and having bearings on extensions of the main shafts. The connecting rod shown at *c* is journaled at *w*, and slotted at the outer end to allow it to move endwise over the stud *x*. It will be readily seen that as *w* descends, the rod *c*, acting as a lever of the second class, with fulcrum at *x*, load at *z*, and power at *w*, will force the pin *z* past the centers. The movement is reversible, and is adapted to much higher speed than is called for in the enunciation of the problem. The mechanism is all carried on the extensions of the shafts, although it would be much simpler if the pin *x* was supported from the base. Allow me to add my token of appreciation for this interesting series of articles."

I will close the present article with a solution contributed by Mr. Edward H. Wright, of Hudson, N. Y., promising, however, that some curious and unique solutions are reserved for a future article. Fig. 9 is a plan, Fig. 10 an end view, and Fig. 11 a side elevation of Mr. Wright's device, who describes it as follows:

"*A* and *B* are the disks with their spindles, upon which are placed two cams, *C* and *D*, of equal size and the same shape. *E* and *F* are the roller guide rods, with arms *E* and *F'*, to which are attached the four rolls *G*. These rods slide in their guides *H H*. The roll *G* in the cam *C*, on the arm *F'*, has the same position in the groove of *C* as the roll *G*, on the other end of the arm *E*, has in the cam *D*. Also, the roll *G* in the cam *C* on the arm *F* has the same position in the cam as the roll *G*, on the other end of the arm *F'*, has in the cam *D*. Therefore, on turning the driver *A* in the direction of the arrow, the cam *C* will force the roll *G* on the arm *E*, as indicated by the arrow, which will, in turn, force the cam *D* also in the direction as indicated. At the same time, the cam *C* will force the roll *G* on the arm *F* with the roll on the other end of the arm *F* in the direction of the arrow *K*, which will, in connection with the arm *E*, drive the cam *D* in the same direction as the cam *C*. Thus, by using the two arms, *E* and *F'*, each to work on a different position in the cams, there will be no dead center. I also think the device may be run at a much faster speed in either direction than is called for in the statement of the problem."

The Founding of Statues: With a Review of the Art as Practiced by the Ancients, and Up to the Present Time—II.

BY S. BOLLAND.

Models, in clay or plaster, of large statues are now supplied by the sculptor, from which a correct impression in plaster is at once obtained by the founder. Such a model of an antique bronze of the Townley Venus is shown at Fig. 1 (page 5), a plaster impression of which is obtained by first marking off two or more main divisions of the model and noting the parts which, owing to the peculiar depressions on the surface, would fail to separate from the model without fracturing the part; these found, a separate piece of mold is formed in plaster at such places, the outer portions of which will leave their impression in the outer copes. The copes are formed by running plaster over the model, the several divisions of which are obtained by constructing a wooden or clay boundary at the points where it has been determined to separate them, and are held firmly together by skeleton frames constructed with iron bars which are laid in the plaster during the process of covering the model. After these divisions have been made in this manner, one by one, and have become sufficiently set or hardened, they are carefully lifted away, set down on their backs, and the false pieces or cores withdrawn from the model and set in their re-

spective seatings in the copes. A correct impression of the model, no matter how intricate its form, is thus obtained over which, after well oiling, the requisite thickness is laid on in wax by repeated coats applied with a brush. The mold being now ready for forming the core within, a suitable core-iron is formed by attaching cross-bars to one or more main central rods, such cross-bars reaching into the remote parts of the core as seen at Fig. 2; this skeleton core-iron is then placed in position inside the prepared mold, and, after making the necessary preparations, by means of pipes, *A A*, for conveying away the gases from all remote parts, the composition or cement is poured therein from the highest part of the mold. The cement commonly used for cores in bronze castings is composed of two parts of finely ground fire-bricks to one part plaster of paris mixed with water to the consistency of cream.

The setting or hardening of cores formed from these materials takes place very soon so that the plaster copes may be taken away almost immediately. By exercising care this may be done without much, if any, damage to the surface of the newly formed wax model. The core, surrounded with its wax fac-simile of the original model, is now stood on a suitably provided base and only needs the requisite anchors for keeping it in position when the wax has been melted out, which emergency is met by inserting, at suitable places, rods of bronze through the core, as seen at *B B*, Fig. 2, the ends of which standing out some distance from the figure, are made secure by being cemented firmly into the cope, when the latter is duly formed.

The next process is to connect the wax of the figure with a number of holes provided at the base as shown at *C C*, by means of outlets composed of the same material; also to attach wax running gates, *D D*, at such places and in such number and size as will insure a safe and clean pour. The gases generated inside the mold when it is cast are led away at the top by means of vents direct, or they may be formed in the same manner as the gates in wax.

After inlets, outlets and vents have been all secured to their respective places on the figure, the whole surface is painted over with a fine composition of some kind; some use fine brick-dust mixed to a consistency with thin glue water whilst others prefer the white of egg, or molasses, according to the nature of the work. When about one-quarter inch of this composition has been laid over the surface and become moderately hard, the common or ordinary loam, with a plentiful admixture of horse manure or cow hair, may be applied, and a backing of bricks built round, after the usual manner. It is usual, in some cases, to surround the bricks with iron curbs at once, so that all danger from the jarring incident to pit ramming may be avoided.

Whatever method of firing be adopted it is necessary that these molds, inside and outside, be thoroughly dried.

As will be readily seen the wax thickness, followed by gates and vents, will begin to flow out at the lower apertures, *C C*, Fig. 2, as soon as the heat begins to take effect, and a constant flow will continue until every portion of wax will have run out, leaving the core and cope held in their true relative positions by the bronze rods, *B B*, previously spoken of.

When the whole has been thoroughly dried it only remains to plug the lower apertures, *C C*, through which the wax has escaped, form the runner basin, and all is ready for running in the metal.

The wax used for the above purpose is composed of one part each of tallow, turpentine and pitch to ten parts of wax. The fine surface of these molds absorbs more or less of the carbon of these ingredients, and by this means is rendered sufficiently refractory to resist the burning quality of the molten bronze, and it is to this happy combination that the beautiful results of the *cire perdue* process is owing.

Sometimes these main copes, as provided by the method explained above, are at once filled with the core composition, after the skeleton core-iron has been placed therein, the copes being then taken away and the thickness pared off by the molder, after which they are again adjusted round the core, and the space run full of wax. The process is to be then continued as before explained.

The molding of statuary in cast-iron is almost as exclusive a business as that in bronze. The various manipulations must necessarily be more difficult because the materials used for constructing the molds, being more open, are proportionately less tough, and, consequently, greater ingenuity is demanded to construct the molds so that they will endure safely the handling to which they are subjected.

Cast-iron in a molten condition, being hotter than bronze, remains fluid longer; this, added to the fact that when the former metal is used the castings must be much thicker than the ones in bronze, makes it much more difficult to obtain a smooth surface, because as long as the metal is in a fluid state, and aided by the pressure behind, it is melting the non-refractory

Antique Bronze of the Townley Venus.

Fig. 1

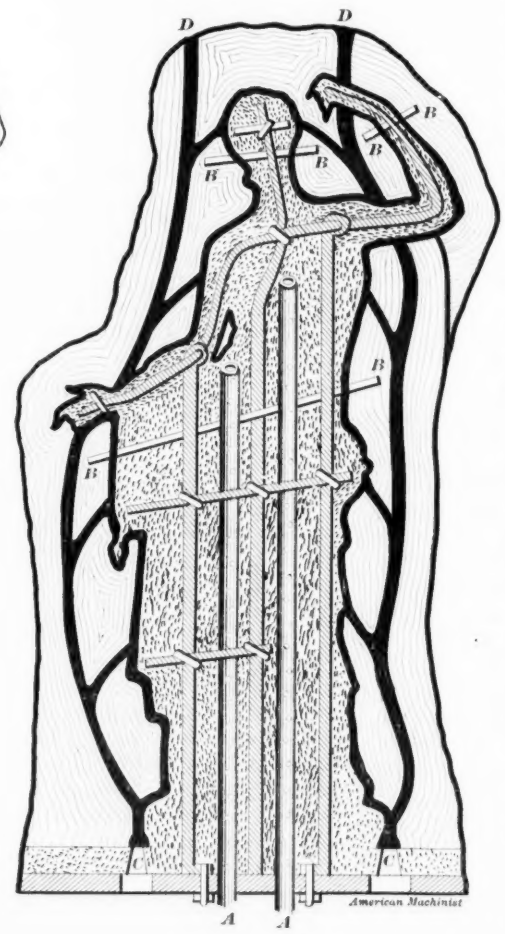


Fig. 2

FOUNDING OF STATUES.

particles of sand on the surface, and forcing its way into the coarser materials of which the mold is made. To obviate this as much as possible is one of the chief processes in the production of cast-iron statuary, and no expense is spared to obtain the most refractory facings known.

For cast iron statuary the sculptor must first secure the services of a competent molder, who proceeds to form the core according as he is directed. Of course the molder must follow the instructions of the sculptor in everything pertaining to the contour of the core, but he must use his own judgment in arranging all the supports, anchors, vents, etc., according to the nature of the work before him. After the core has been duly formed by the molder the sculptor proceeds to form his figure thereon, using fine clay for the purpose, which, like any ordinary piece of loam work, forms the thickness and is taken off when the impression has been obtained. The molder in building his cope around the figure takes cognizance of all its irregularities, and provides for a correct separation of all its parts with as little damage as possible to the original design. According to the depth and direction of the various depressions on the surface of the statue, so will the number and complexity of the division of his mold be. During the process of building provision is made for pouring by placing running gates at favorable points; hooks and staples are inserted in the various small pieces, or false cores, which must necessarily be formed separate from the main copes, these hooks being afterwards used for fastening them to the main cope before the final closing of the mold. The separating of the mold is a delicate operation requiring considerable experience and judgment on the part of the molder.

After all the parts have been built around the statue the edges of the joints are made even and guide marks made so that the final closing may be facilitated; they are then taken away, one after another carefully, till all have been removed, after which the clay figure or thickness is removed and the mold, inside and outside, treated after the manner usual for ordinary loam work, dried thoroughly, closed together, rammed in the pit and cast.

The system of molding colossal statuary in pieces, to be afterwards joined together by pinning, etc., is fast gaining favor where the old prejudices regarding the supposed discredit of producing statues piecemeal have disappeared, and very many of these figures, including the Statue of Liberty, New York City, are now made in this manner. Cost for transportation, risks in molding, chances for unsoundness and weight of metal used in molding colossal statuary by the old methods, are by this means considerably reduced, whilst it is claimed that all seams can be so neatly fitted as to defy the keenest scrutiny to discover where the junctions have been made. It is also claimed that by this separation into convenient sections they can be easily made in sand, which gives a better impression and greater regularity of thickness; also that the thickness can be easily arranged to give the most metal where the greatest strains exist.

The process of molding in sections is to divide the plaster model at such places as will be most favorable for molding, due consideration being given to the parts which will best hide the points of junction, when they are joined together. The cutting is done with small saws, and after the several pieces have been provided with the requisite tenons and mortices for joining together when cast, and any weak parts strengthened by cross stays, should the model be hollow, they are ready for the molder.

The flasks for this class of work are not necessarily different to those in ordinary use, except that the nicest fit is indispensable. Three pieces of flask are needed, one being simply a frame; the other two, although constituting upper and lower flasks, are to be both barred, and for that reason may be both called copes. On account of the irregularities of the surfaces they are usually made with loose bars. These flasks are always best when they are made interchangeable. For molding the outside of the piece of model which we will suppose to be a portion of the body of Fig. 1, one-half of the model is set into the frame piece as a roll-over flask; the ends are then rammed flush with the model, and the outside formed by ramming false cores all round if necessary. These false cores overcome all difficulty with regard to broken and uneven surfaces, as they can be made to separate at such places and in a direction favorable to a clean lift. When these false cores have been all formed out of fine tough sand, suitably strengthened with irons, and provided with the necessary lifting staples, also the running gates set therein at the proper places, a joint is made over all with parting sand and the first cope set thereon and rammed. This done, the cope is lifted and set down on its back, the false cores are taken off the model and placed in their respective places in the cope, which now presents the exact impression of this side of the model and must, after due preparation, be used for ramming the first half of the main core.

The opposite side of the model is now treated exactly as was the first up to the point of lifting the cope, which, when rested on its back, must not have the false cores placed therein, as in the first cope, until they have been utilized for forming the upper half of the main core. As before stated, the first half being duly prepared by laying thereon a thick coat of parting sand, a layer of core sand is then spread all over, and the core-iron placed in position; and after due provision has been made for vents and supports—somewhat after the manner shown at Fig. 2—the lower half is rammed level with the joints of the first false cores; the upper half is then formed by placing the false cores of the second half in their respective order over the lower ones, continuing the ramming of the main core inside as they are thus set over alternately; thus, step by step, continuing the process until the last false core has been so placed, and by this means the main core formed. The false cores are now lifted away and secured into their respective seatings in the second cope.

All that now remains to be done is to shave off the thickness at this half of the main core, cover with the roll-over flask, fill with sand and ram hard enough to support the core, which, when the two flasks have been fastened together, is reversed, the cope lifted off and set down on its back like the other. The false cores are now lifted off the main core and secured in their seatings when the remaining half of the main core is shaved down, the molds finished and blackened, and all is ready for the oven.

All sands for false cores and other intricate parts of the outside of molds, made like the above described, should be of a fine, tough, but open nature; whilst that for the cores should be chosen principally for its openness.

For very small statuary in bronze it is only necessary to make a small block core out of the porous cement, which though porous is very tenacious and admits of being cut and filled to any form required. When this has been formed and due allowance made for thickness, the artist proceeds to lay on the wax, on which he may, according

to his ability, bring out the most delicate lines and curves imaginable. When the figure has been completed on the wax thickness, it only remains to thrust a few wires through the whole, and surround it with an iron flask, filling the space between with the porous cement. By the application of heat the wax is caused to run from the mold at the bottom, through holes provided for that purpose, and, as the core is held in a correct position by the wires which are firmly fixed in both the inner and outer cement bodies, the mold, when dry, can be turned with the holes on top; the latter serving the purpose of running gates for filling the space, previously occupied by the wax, with metal. The greatest care must be exercised in this, as in the other methods, to have the mold thoroughly dry and free from steam, and beside vents from the core, there must be free vents from all points in the casting in which air or steam might get confined. By this means, the most remote and delicate parts of the mold are reached by the fluid metal, and a good impression of the whole of the original wax figure obtained.

The figure to be produced in bronze may, if not too large and unwieldly, be worked direct after this manner: A plaster cast of the figure, previously wrought and finished, or any other finished object, is the pattern from which the molder takes an impression in two halves. These impressions are carried off the model in stout iron skeleton frames after the manner previously described. The material from which they are made being, in this case, composed of a mixture of one-third plaster of paris to two-thirds fine brick-dust, made to the right consistency with water, not only enables the molder to take a good impression of the model, but being made porous, by the brick-dust introduced, may be used as molds proper for the outside. Sheets of fine clay are now rolled out, and spread evenly all over the surface as thick as it is intended the metal should be. When this has been done the molds may be clamped together, and the inside filled with the same mixture as for the copes, but if the core is large or complicated the skeleton core iron must be used as in the cases before mentioned, not forgetting to make provision for carrying away the gas from the heated core, etc. The mold can now be again separated, the core lifted out, and the thickness removed; and as it is really composed of a top and bottom flask, the joints may be utilized for carrying the air and steam from the interior of the mold to the top by means of gutters cut therein. If it is thought advisable to run the metal into the mold at any point below the top, gates may also be prepared in said joint. When copes and core have been thoroughly dried, the closing proceeds in the regular way, excepting that all studs required for holding the core in position must be made of bronze.

All that remains to be done after the upper half has been closed over is to bind the whole firmly together with stout iron clips provided for the purpose, elevate the mold to the required angle, make the pouring basin and cast. The nature of the materials used for both core and cope in this instance admits of no half measures in drying—this must be absolute.

The model or pattern, in this instance, is saved.

No country equals France for the number of its fine art foundries, the principal ones being in and about Paris. The most systematic methods prevail, and no effort is spared that will enable them to maintain the supremacy which, at this day, rightfully belongs to them; economy is studied in every detail of management, as exactly as it is in the best managed factories of the day. Some of their inventions for the treatment of art work in the foundry are of world-wide reputation, and must be seen to be fully appreciated.

The Egyptian bronze consisted, according to Bessari, of two-thirds brass and one-third copper. Pliny says that the Grecian bronze was formed by adding one tenth lead and one twentieth silver to the two-thirds brass and one third copper of the Egyptian bronze, and that this was the proportion afterwards made use of by the Roman statuaries.

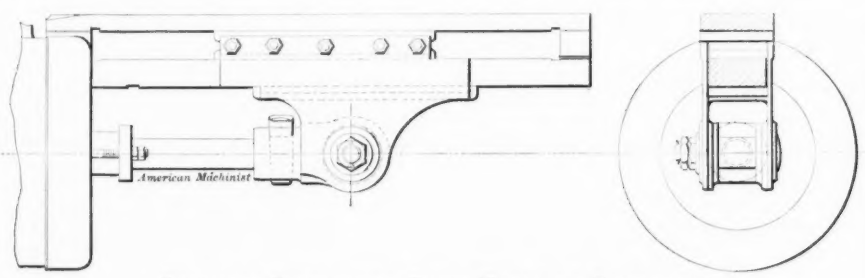
The modern bronze is commonly made of two-thirds copper fused with one-third brass, and recently, owing to the great demands for ornaments and decorative furniture, lead and zinc in small proportions have been added. These additions, it is said, increase the fusibility of the alloy, and facilitate the process of casting.

In mixing plaster never pour the water on the powder, but shake the powder into the water, taking care that it does not run into lumps. Proceed in this manner till the powder comes to the level of the water and then stop, if a thin plaster is wanted; a little more if a stronger plaster is needed. Amateurs commit the error of being too hasty in their movements, stirring the whole as it is being poured, and using too much of it. When the whole of the gypsum has been poured in, allow the ingredients to remain undisturbed for a few seconds, and then stir gently with a spatula; when it has assumed the consistency of cream, pour at once into the mold; it will then set in ten minutes, and be ready for taking out in half an hour.

Locomotive Crosshead.

The aim in designing this crosshead has been to maintain a more accurate alignment of piston rod, thus reducing wear in cylinder to nearly that of packing rings only, and to increase the length of service of gibs by increasing the wearing surface on up thrust 100 per cent., on down thrust 30 per cent., without change in guides now in general use.

This is obtained by taking advantage of the clearance of the ends of guides and



IMPROVED LOCOMOTIVE GUIDE BARS AND CROSSHEAD.

adding a third bearing under bottom of lower guide, thus allowing the extension on the back end of crosshead, the whole arrangement being clearly shown by accompanying drawing which gives views of crosshead and guides in elevation and section; the drawing having been made with as few lines as possible to show clearly and avoid complication.

This arrangement combines all of the good qualities of the square bar and Laird guide giving ample wearing and guiding surface in a most compact form. These large surfaces will also admit of using cast-iron for gibs and guides, as the increased wearing surface reduces the pressure per unit of area, and therefore reduces the liability of forcing the oil off the surfaces of contact.

This design of crosshead is the invention of S. H. Kenyon, Pittsburgh Locomotive Works, Pittsburgh, Pa.

Car Heating in France.

Commenting upon the heating of cars in France, our contemporary, *The American Engineer and Railroad Journal*, finds fault with the cutting off of the steam from the heater when the temperature of the car reaches 59° F. There is nothing extraordinary in this when climatic differences are understood. The room of an invalid in England is supposed to be maintained at 60° F. If this is sufficient for an invalid there can be no great harm in 59° F. for a car. The trouble with the cars in Europe is that they are often not heated at all, but no one would complain at 59°. It is well known that new arrivals in Australia, who pass the first winter in summer clothing, will wear an overcoat during the second winter when the thermometer registers 70° F. Now 70° F. is certainly very uncomfortably warm for a car in England. It is all a question of climate. In Britain, a summer temperature over 80° in the shade is considered excessive, and is quite rare.

LETTERS FROM PRACTICAL MEN.

Restoring the Surface of Tracing Cloth—Marking on Blue Prints—A Simple Section Liner.

Editor American Machinist:

For restoring the surface of tracing cloth after erasing, the best method I have found is burnishing. Place a triangle of hard rubber or celluloid—anything having a hard smooth surface—under the spot to be burnished, and rub the spot with anything hard having a polished surface, such as the side of a knife blade.

Other methods for restoring the surface, such as varnishing or polishing with soapstone, require too much time, and so are used only when a comparatively large surface is to be treated.

For marking or making changes on blue prints, the alkaline water commonly used is unsatisfactory, because in a few days the figures and letters are very liable to become an unintelligible blot. For this work the most satisfactory ink I have used is made by rubbing down some Chinese white with alkaline water, adding a very little mucilage for body to keep the white in suspension. This ink will work as nicely on blue prints in either the drafting pen or writing pen, as drafting ink does on paper, the lines being sharp and clear, and having no tendency to spread or run.

A makeshift for a section liner can be devised from a bow pen or bow pencil. Set the needle point a little shorter than the pen or pencil point, and the opening between the points the distance required between the lines. Then having drawn the first line move the triangle back until, having the pen or pencil point against the triangle, the needle point will be over the line just drawn; then draw the next line, and so on, placing the needle point over the last line drawn.

J. J. EWING.

The Growth of Cast-Iron.

Editor American Machinist:

In conversation with my friend "John" the other day (who, by the way, is an expert in the machine line), on the above topic, some facts were noted corroborating a theory regarding it.

Now, as "John's" experience covers many years at the business, and being withal somewhat shrewd at observing, many items and circumstances are at a ready hand for him to tell to the less informed inquirer. Cast-iron expands by heat (and for that matter other materials too) at a certain ratio to the number of degrees it is subjected to. To obtain a required sized casting from the foundry, the pattern furnished them must measure up all round $\frac{1}{8}$ of an inch to the foot larger; this is a common rule in pattern making for cast-iron; but that is only for the size of castings when first obtained.

My friend "John" many years ago was in the employ of a manufacturing company as a tool maker, etc.; the firm used some cast-iron boxes for annealing and case-hardening purposes which, when new from the foundry, measured 24 inches long, 9 inches wide, 10 inches deep, with sides $\frac{1}{8}$ of an inch thick; one day the "super" thought it best to get a new supply of the boxes; so the machine man or tool maker was sent to order them at the foundry, being instructed where to find the company's pattern. "John" measured up one of the old boxes, and made his way to the foundry and pattern loft; he found a pattern where directed to find it; but as it measured much less every way, he concluded that there must be another pattern, and so informed the "super"; both went to the pattern loft and the "super" informed "John" that the boxes he measured were made from that pattern; this led to an investigation in regard to the size and weight of the boxes when new, and after being used for some time, and it was found that the boxes which originally measured 24 inches long, 9 inches wide, 10 inches deep, with sides and bottom $\frac{3}{8}$ inch thick, had grown to measure about 25 inches long, 10 inches wide, 11 inches deep, with sides and bottom $1\frac{1}{4}$ inches thick, and weighed correspondingly more than when new; question: Does cast-iron grow or increase in size by being continually heated for a space of time; or does repeated heatings and allowing it to cool gradually increase its size and weight; if so, where does the additional cast iron come from?

Later on, my friend went into the machine business himself, and being a natural expert had many bad jobs to "tackle" which would bother any ordinary man to get out in good shape.

Some years ago a firm bought an engine of about 30 horse power; after a time it developed a fault which gave some trouble, viz., a loosely fitted crank. "John" was called upon to prescribe for the sick crank. He had crank and shaft brought to his shop; the crank was taken off, and the end which (did not fit) fitted the shaft was heated gradually to nearly a red, and allowed to cool off gradually several times; lastly, it was heated as before, and placed in position on shaft and allowed to cool off as before, and the result was it shrunk on to the shaft solid, and, without doubt, is as solid to day if in existence. That end of the crank grew by repeated heatings, so that the hole grew smaller, while the rest or outside portion enlarged. The number of heatings was discontinued when the hole calipered small enough for a "shrink on fit."

Once more. A pump having a piston valve needed a new one. Our friend was called upon to do the job; not having a man handy to set immediately at the job, did it himself. To obtain the correct size it was necessary to reach in some distance with an inside caliper and transfer measurement to an outside caliper. In the usual manner it was turned to size with the intention of draw-filing it to fit properly; but on trying it after it was turned he found it was the correct size, and to draw-file it would make it too free a fit. Then came the necessity to enlarge it in the following manner: It was heated, and allowed to cool off gradually, and when the second trial was made it was found necessary to turn off quite a chip in order to get it small enough to fit by the draw-filing. I will say to the credit of my friend that he can and does fit correctly if he has half a chance to measure, but this was a bad hole to get at; but he got out of it, as it was, first-class, because he knows some "tricks in trade." Mark, it was turned too small at first—the size was enlarged by heating, etc., so that it had to be turned the second time; question: Did that piston valve grow by heating? It enlarged did it not? And that may be one definition for growth.

More might be added, but enough for this time.

FRANCIS W. CLOUGH.

An Electric Motor in the Foundry.

Editor American Machinist:

Knowing that you are interested in all the new shop appliances for saving labor, we send you herewith a photograph of a new electric motor which we have just constructed in our own shops here for our own use. These little motors are on the 4-pole type, and may properly be called iron-clad. The electrical horse-power, as shown by tests, is from $1\frac{1}{2}$ to $1\frac{3}{4}$ horse power, at speeds from 1,000 to 1,200 revolutions per minute.

We also send you a drawing-office sketch showing a vertical plan of the arrangement of the fields and brushes. Also a couple of

sketches, one showing the application of this motor to a couple of rotary cylindrical sand riddles in use in our foundry for sifting and tempering molding sand. This outfit has been in operation now for about two months, and has given us very great satisfaction. Before putting this little apparatus into use, it required the services of two men to prepare and temper all the sand for our sixty to seventy molders, whereas with the present arrangement one man does it all in about half a day.

The power supplied to this motor is taken from the dynamo in our automatic engine shop, which is driven from the line shaft, and which ordinarily furnishes the power to our 5-ton Shaw electric crane in use in that shop. The extra power required to drive the sand riddles is unnoticeable, and we feel that practically it costs us nothing.

The second sketch shows an arrangement which we are just erecting in our brass foundry, using a similar motor to drive a brass separator for separating the iron from the brass chips, and also water rattling mill for cleaning and annealing our brass castings.

In both of the places where these motors are put in use, it was impracticable to run a line shaft, or in any other way transmit the power without a great amount of expense for the transmitting machinery, and, as the power in either case is only used a small part of the time, the economy of operating it with a separate motor, which can be started and stopped instantly, is apparent without further discussion.

Our reasons for making these motors instead of buying them were first, that we had a good electrician about our works whose services we find are well worth what it costs in keeping our other electrical apparatus in repair, we having an electric crane, two 60-light arc dynamos, with 57 arc lights, one 400-light incandescent light dynamo, and about 370 incandescent lights, electric fire alarm telegraph, and three electric watch clock circuits. These motors were designed by him, and made practically in his spare time, as far as the electrical work was concerned; the machine work was done by one of the apprentices in our tool room. We also felt that in works of this size, where it was not only probable but possible that we should eventually use a large number of these small motors, it would be much better to make the patterns and have them on hand in case of repairs being necessary. As nearly as we can ascertain, charging up the time and material put upon them, these motors have only cost us about one-third what we would have to pay for them in the open market.

ERIE CITY IRON WORKS,
per WM. O. WEBBER,
General Superintendent.

Those Water Pockets.

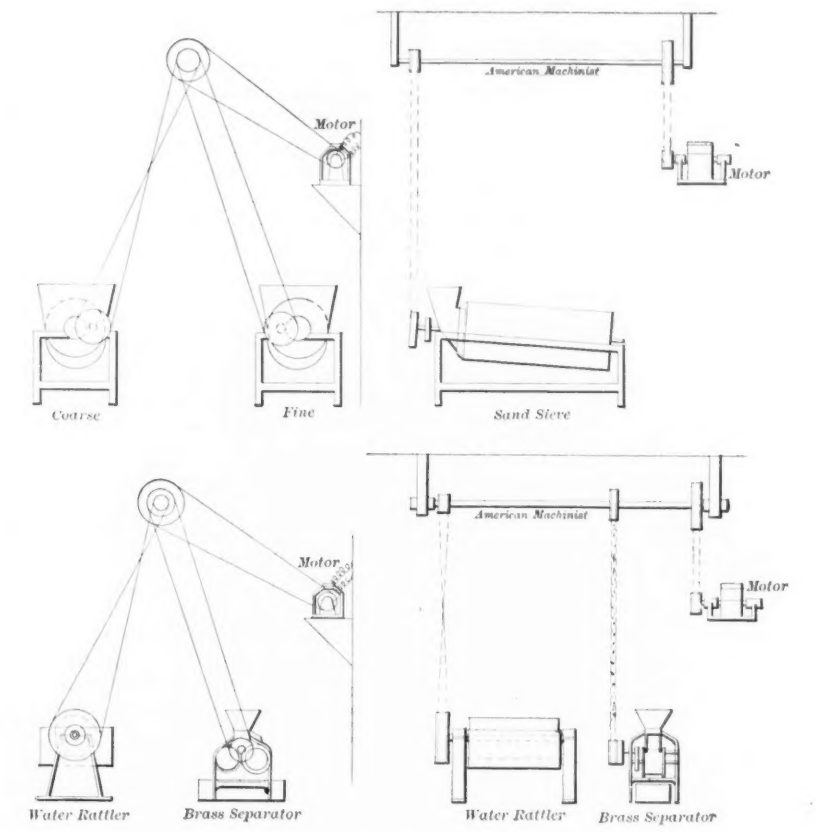
Editor American Machinist:

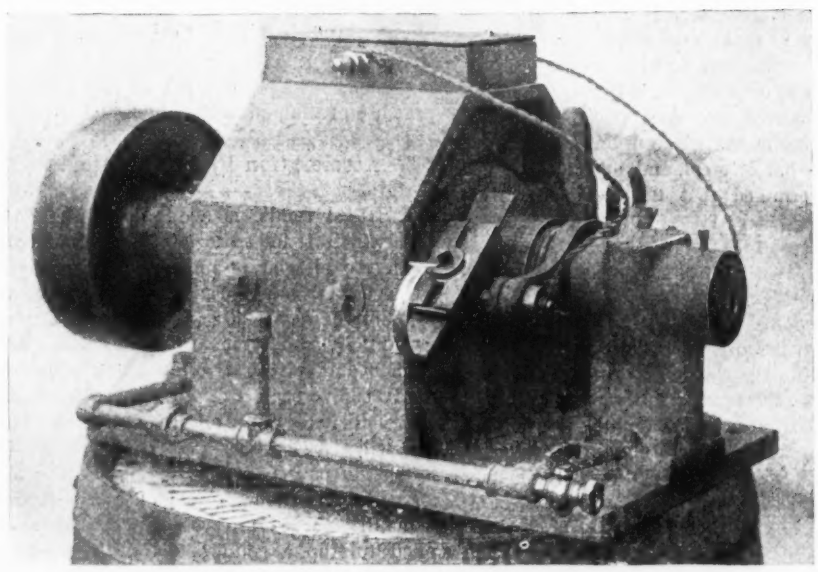
In the light of what has been learned during the past twenty years of the evil effects of condensation and re-evaporation in the cylinder of a steam engine, I should be inclined to enter a protest against those water pockets on the upper surfaces of the pistons of the engines of the "William Windom," illustrated in your issue of August 31. Imagine them filled or partly filled with water, as they surely will be, and this water struck and sprayed by the inrushing steam at the beginning of the down stroke. It appears to me that if this is not the worst possible construction it is at least bad enough. H. F.

The Cause of Boiler Explosions.

Editor American Machinist:

The article on "Boiler Explosions" in the AMERICAN MACHINIST of August 24th is timely, and expresses correct ideas, but I wish to call attention to the fact that public opinion in this matter as in many others is inclined to run to extremes A few years ago many people believed that some mysterious agent caused almost all of the boiler explosions, which so frequently destroyed life and property, and the rest of them were caused by "low water." In fact some manufacturers still believe that it is impossible to explode a boiler that has three gauges of water in it, even if the iron is no thicker than a piece of brown paper; consequently if their man in charge knows enough to keep plenty of water in sight, that is the only qualification necessary.





AN ELECTRIC MOTOR IN A FOUNDRY.

As a majority of the reading public have been shown that these mysterious agents no longer exist, or rather never did exist, and that for every explosion there is a plain cause, they are inclined to think that it is an easy matter to detect defects in boilers before they fail. It may be admitted that this is true in many cases, but it does not apply to all of them, and the reason is a very plain one.

In many of the boilers built at the present time a large portion of them are totally inaccessible, and therefore they cannot be inspected thoroughly. Even with the ordinary multi-tubular boiler, as designed by some builders, there are so many tubes put in that it is impossible to reach some of the parts, either to clean or inspect them. Again, the way that some of them are set answers the same purpose, for we can scarcely expect a steam user to dismantle his boiler settings once or twice a year, when it is not definitely known that defects exist, simply for the purpose of examining them.

The foregoing is not intended to excuse those manufacturers who have old boilers in use, which have not been thoroughly inspected for many years, their only objection being that to do so would make it necessary to remove a few bricks. The idea of having the exact cause of every boiler explosion ascertained, and all of the particulars published, is a very good one, and it will be a good thing for engineers as well as the public at large, when it is put into practice, but after all it is of the same nature as the idea of shutting the stable door after the horse has been stolen.

When the owner or operator of a factory refuses to allow his boilers to be examined, though there is good reason to believe that defects may be found, measures should be taken to publish the fact, and have it put on record, and then if disaster follows, it will be an easy matter to place the responsibility where it belongs. If such publication is objectionable, then let him avoid it by having every part of his boilers carefully examined. It seems as though no reasonable objection can be offered to this plan.

W. H. WAKEMAN.

Protection of a Trade Name.

The Singer Manufacturing Co. has recently been successful in stopping the practice of selling sewing machines in England made in imitation of theirs as "Singer" machines. The justice before whom the case was tried said in his decision:

"Any honest manufacturer or trader who really did not desire to get the benefit of the plaintiffs' trade name and their advertisements and reputation ought to and would take care so to use the word 'Singer' as applied to sewing machines as to prevent any possibility of doubt or deception"; and further, that "it was certainly of the utmost importance to the plaintiffs that they should preserve their trade name. From the evidence," his lordship said, he "gathered that some manufacturers and dealers, especially foreign manufacturers and dealers, desired unfairly to get the benefit of the plaintiffs' trade name and reputation. The method adopted was gradually to eat away the plaintiffs' rights. The system was one commonly adopted in cases of this kind. A slight attack is made in the first instance on the trade name by a user which may to some appear trivial, and as only slightly infringing the trade name. That is persisted in for some little time, and made a step for a further advance upon the trade name, and so on, until at last the unfortunate manufacturer, if not zealous in protecting his trade mark, or trade name, finds, after the lapse of some time, that the whole benefit has been taken away from him. Any steps in this direction ought to be carefully watched by the Court, and stopped, if unfair, even although, in some minds, one particular step made in that direction may not show itself as being of very great importance." Mr. Justice Romer added, "It is only by great vigilance that a trade name can be properly protected."

According to the Rochester *Times*, a curious failure of a car wheel took place there recently. The hub of one of the wheels of a mail car broke out of the wheel, leaving the wheel loose upon the axle. The journal and wheel were very hot when found, and it is thought possible that this heating was responsible for the breakage.

We suppose some one in Wellington, Shropshire, England, may be wondering why the specimen copy asked for is not sent. It is because no name was signed on the postal card, and we do not know to whom to send it.

Members have been notified that the regular annual meeting of the A. S. M. E. will take place at the society's house in this city December 4, 5, 6 and 8.

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☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

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CONTENTS.

	PAGE.
Ninety-inch Forge Lathe	1
Columbian Exhibition Notes By F. J. M.	1, 2, 3
A New Emery Grinder	3
On the Cultivation of the Inventive Capacity by the Solution of Constructive Problems. By Leicester Allen	3, 4
The Founding of Statues; With a Review of the Art as Practiced by the Ancients, and Up to the Present Time. By S. Bolland	4, 5, 6
Locomotive Crosshead	6
Car Heating in France	6
Letters from Practical Men: Restoring the Surface of Tracing Cloth—Marking on blue Prints—A Simple Section Liner. By J. J. Ewing The Growth of Cast-iron. By Francis W. Clough An Electric Motor in the Foundry. By Wm. O. Webber Those Water-Pockets. By H. F The Cause of Boiler Explosions. By W. H. Wakeman	6, 7
Protection of a Trade Name	7
Headquarters at the Fair	8
There is Always Some Distortion	8
Protection of Patents	8
Acceleration by Retardation	8
French Engineers in New York	8
Literary Notes	8, 9
Questions and Answers	9
A Curious Engine Disaster—Specializing Machine Work. By W. H. Booth	9, 10
Graphical Determination of Weights of Flywheels of Steam Engines. By Emil Theiss	10, 11
Making Wheels in Halves. By P. S. Dingey	11, 12
Lightning Conductors	12
Some Nonsense	12
Manufactures	12, 13, 14
Machinists' Supplies and Iron	4

Headquarters at the Fair.

During the continuance of the Chicago Exposition the AMERICAN MACHINIST will have its headquarters in the space allotted to the Mechanical Press in Machinery Hall. The exact location is Section No. 27, Column K 37. Word can be left with the attendant there by any one who is desirous of meeting a representative of this paper, who may at the time be engaged elsewhere on the grounds. As the majority of our friends who visit Chicago during the continuance of the Fair will spend a considerable portion of their time in Machinery Hall, we invite them to make use of our facilities there by having their mail addressed in our care as above, where it will be cared for and delivered on demand either by our own representative or by the person who cares for the space in which our desk is located.

There is Always Some Distortion.

One of the things that most machinists have to learn is that they are not working with materials that are really "unyielding," as iron and steel are commonly considered to be, but with materials that yield readily to every strain imposed upon them.

It is far too common when shaping parts of machinery, or when erecting machines, to impose strains of various kinds upon them, and assume that they do not change form on account of those strains. Instead of this it should be more fully realized that in every case there is a change of form, depending upon the character and amount of strain; and whether or not this change of form will be prejudicial should be considered.

A cast beam, specially designed for extreme rigidity, will yield readily to a small transverse strain, as is perhaps best shown by bench measuring machines, in which, though the bed of the machine may be what we call extremely rigid, yet a small lifting force applied to one end of it produces a very perceptible effect in the way of bringing the contact points together, an effect which is readily perceived by the present refined methods of measuring.

One of the most vivid proofs of the extreme elasticity of steel is afforded by a very interesting experiment made by Sellers Bancroft at the works of William Sellers & Co. Three cylindrical steel posts, 1½" diameter and 10" long, were placed in a vertical position upon a steel disk, the three posts arranged in the form of a triangle. On top of these was placed another steel disk and arrangements were made by which a pound weight could be very carefully placed upon or removed from the upper disk. An electrical contact was arranged in such a manner that any diminution of length of the columns would cause a bell to ring. It was found that this pound weight was sufficient to make and break the contact, the bell continuing to ring so long as the weight was in place and stopping whenever it was removed.

By experiments made upon specimens of the same bar of steel, and by calculation, it was determined that the steel bars were compressed $\frac{1}{14,000,000}$ of an inch, which, it is true, is a very small amount, but then one pound is a very small load for steel posts capable of supporting over 200,000 pounds without permanent deformation, *i. e.*, within the elastic limit of the material, and the experiment shows that even the lightest strains cannot be imposed upon the materials we handle without a corresponding yielding; which yielding may or may not be disregarded according to circumstances.

To this fact that metals always yield under strain is undoubtedly due much of the "wearing to a bearing" that is often considered necessary in new machinery. Machine spindles ground and lapped accurately to a bearing while unloaded and subjected to no strain may not be to a bearing when loaded and in operation, especially if subjected to transverse strain.

Engine crank-shafts deflect by the load of the fly wheel and other strains put upon them. Surfaces scraped to a surface plate are no longer true when differently loaded, or when the weight of the machine itself is allowed to produce distortion.

In this connection, the way in which Professor Sweet was led to suggest that machine tools should rest upon three legs is of interest. In the machine shop at Cornell University they had a small planer that would plane "winding," and Prof. Sweet noticed that the work was not always in wind the same way. He then noticed that the direction of the winding depended upon which side of the planer the heavy chuck rested upon the floor, and by moving this chuck from one side to the other he could make the planer take a heavier cut upon two diagonally opposite corners of a piece of work, over which a cut had previously been taken. By so placing a jack screw as to raise the legs at one end slightly off the floor, and then moving this jack screw laterally until by trial its proper position was determined, the planer was made to plane true, and the chuck could be placed upon the floor at either side of it without affecting the work.

This showed simply that floor and planer yielded sufficiently to produce a noticeable effect upon the work.

Protection of Patents.

Thomas A. Edison is, it seems, very much dissatisfied with the present laws relating to patents, and has been quoted as saying that no more patents were to be taken out by him. Speaking of a cure for the evils of the present system, Mr. Edison said:

"Well, I should say that the one simple thing which would cure it would be such a change in the procedure of the United States Circuit Courts that when a man came before the court with a patent charging that some one was infringing, he should have a preliminary injunction at once restraining the pirates until they themselves proved that the patent was not a valid one. That would be only justice to the man who had gone through all the work and trouble of pioneering an invention and introducing it to the public before the appearance of the pirate upon the scene. Certainly on all the lines of common decency and justice the man who has been the pioneer of a patent is entitled to the benefit of the law."

At first sight this remedy looks well enough, but the fact is that there are many cases in which perfectly honest persons are charged with infringement; and where such a person, believing in his perfect right to do so, has gone ahead and built up a manufacturing business, it does not seem right that simply because it is asserted that he is infringing his business should be stopped and perhaps permanently injured, pending a decision of the courts, which may be delayed for months and even years. Especially would this seem to be unjust in view of the fact that if it is finally decided that there has been an infringement, the infringer is always required to pay for the past use of the patented article.

Acceleration by Retardation.

A friend sends us a clipping from *The Sun* which is an editorial article founded upon the alleged opinion of a locomotive engineer and others, that the reversal of a locomotive may cause the train to shoot ahead more rapidly instead of checking its momentum, and that to the fact that locomotives have been reversed are due some of the collisions that might otherwise be avoided.

This, of course, is simply a case of erroneous observation of phenomena. It is generally agreed that when brakes are applied to stop a train, and the force with which they are applied is sufficient to slip the wheels upon the rails, the retarding effect is considerably less than when applied with a force just short of that point. The same may be true of driving wheels driven backwards by steam instead of retarded by it or by driving-wheel brakes; but it might be well for those who think that slipping or reverse motion cause an acceleration of the train's motion to try running trains over the road on that principle. When an engineer sees before him the probability of a disastrous collision is not a good time to expect of him accurate and reliable observation of what takes place.

French Engineers in New York.

The visit of the members of the Société des Ingénieurs Civils to New York as guests of those American engineers who were at Paris in 1889, proved a very pleasant occasion, and seemed to be very much enjoyed by the visitors. They were met upon arrival Sunday morning, the 3d, and suitably welcomed, the festivities beginning on Monday with a breakfast at the Engineers' Club, after which carriages conveyed them through Central Park to the gate house of the Croton Aqueduct, where Chief Engineer A. Fteley explained the work. Proceeding then to Washington Bridge, R. H. Hutton, the engineer of that structure, was met, after which they proceeded to examine the new water-works construction under the guidance of the engineer, A. P. Boller. Driving the entire length of Riverside Drive, the Twenty-sixth street station of the Edison Electric Illuminating Company was then inspected. The principal feature of Tuesday's entertainment was a luncheon in the banqueting room of the Equitable Building, during which a number of addresses were made. After this the Houston street power house of the Broadway Cable Road was inspected, and a visit made to the Brooklyn Bridge under the guidance of T. C. Martin, the engineer.

Wednesday the party took passage on the "Laura M. Starin" at foot of East Thirty-first street, and went up the river to the works of the De La Vergne Refrigerating Company, and returning down the river under the bridge inspected the Sound steamer "Puritan," and the terminal station of the Pennsylvania Railroad.

No assignment was made for Thursday, this day being set apart that each visitor might pursue his own inclination, or attend to business affairs before departure for Chicago, which took place by special train Saturday, 9th.

The engineering class, 1893–1894, at the Young Men's Institute, 222, 224 Bowery, New York City, will be re opened on the evening of the first Wednesday in October, and thereafter the class will meet every Wednesday and Friday up to the following May. It will be in charge of Wm. H. Weightman, an engineer who has had considerable practice and experience in the field of engineering. He has had charge of this class for several seasons, and the interest evinced by his scholars, and the progress made by them are evidences of the popularity and qualifications of the teacher. This is an opportunity which should not be missed by young men who wish to improve themselves in this line of study.

Literary Notes.

We have received from Angus Sinclair, Secretary, a copy of the "Reports of Proceedings of the American Railway Master Mechanics' Association, Twenty sixth Annual Convention," held at Lakewood, N. J., June 19–21. We have already given a running account of the meeting, and it is only necessary to say that this book gives a complete and detailed account of what took place there, conveniently arranged for preservation and reference.

LOCOMOTIVE ENGINE REPAIRS. By L. C. Hitchcock, General Foreman of "Soo Line" shops.

This is a little book intended especially for machinists who work upon locomotive repairs, though it contains many suggestions that might prove useful to machinists doing almost any kind of work. The author takes up in separate chapters, and explains the principles and methods followed in doing the more important repair work upon locomotives—does this in a plain, straight-

forward manner, and uses engravings wherever necessary. The book is well printed, bound in flexible cloth covers and sells for 50 cents by its publishers, the Debs Publishing Co., Terre Haute, Ind.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(453) E F., Jersey City, N. J., writes: Kindly inform me of an evening mechanical drawing school, other than the Cooper Union, as on account of the overcrowded condition of this school I failed to gain admission. *A.*—Apply at the engineering class of the Young Men's Institute, 222 and 224 Bowery, New York.

(454) O. A. B., Harrisburg, Pa., writes: I am anxious to know what books to study for a better preparation to enter college; electrical engineering is my object. What schools would you suggest? *A.*—There are many good technical institutions in your State; we may suggest the Lehigh University at Bethlehem. Write to this institution for particulars relating to the examination for admission, which will probably enable you to make the proper choice of books.

(455) T. C. K., Dayton, O., writes: Please state whether you have ever illustrated a naphtha engine. If not, please give a description of one if not too much trouble. *A.*—A naphtha engine has been illustrated in our issue of June 12, 1886. This motor expands naphtha vapor for power and uses the same vapor in part for fuel. There are other designs in which a vapor is generated from the naphtha and used as fuel for generating steam. In this case the motor is simply an ordinary steam engine. 2. What is naphtha? *A.*—It is an artificial volatile colorless liquid obtained from petroleum. It is a general term applied to the products of the distillation of crude petroleum between gasoline and refined oil. Ordinary petroleum now yields from 6 to 12 per cent. of this material.

(456) H. C. K., Holyoke, Mass., writes: Kindly inform me which is the best metal for a bearing in which a spindle is to run at a rate of 5,000 revolutions per minute without heating. *A.*—For vertical wrought-iron or steel spindles, phosphor bronze makes a good bearing; the spindle in the routing machine shown in our issue of January 31, 1889, runs in phosphor bronze bearings, and makes 12,000 revolutions per minute without heating. Cast-iron bearings are sometimes used which answer the purpose well provided ample provision is made for a continuous lubrication. For step bearings cast-iron is frequently used and works very satisfactorily when it is kept well lubricated. For horizontal spindles a good hard Babbitt metal can be used with advantage in the bearings. Of course, for spindles running at a high rate of speed the best of workmanship is absolutely necessary; if they are not perfectly round, or in perfect alignment, heating of the bearings will be the result. The bearings must also be correctly proportioned for the work they have to do.

(457) X. Y. Z., Michigan City, Ind., writes: There is in course of erection a stand-pipe 110 feet high, 10 feet diameter, base plate 12 feet diameter; total weight of steel, 60 tons. The stand-pipe is not buttressed and stands upon a foundation 5 feet deep in the ground and 6 feet high above the ground, composed of a retaining wall of small stones; the central part is filled with small stones laid in lime mortar—not cement—the whole resting upon a sand bed without piling or other substructure. Diameter of foundation at base is 18 feet. Is this structure safe or should the height of the pipe be diminished? *A.*—From your description we are of the opinion that the structure is safe enbugh, but we do not care to say so positively without examining the ground. However we suppose that the structure is being put up under the direction of a competent engineer; if not, it may be that to repair defects, after the structure has been finished, will cost considerably more than the expense incurred by engaging a competent engineer at the start.

(458) R. W., Louisville, Ky., asks: Which is the best practice in setting a stationary return tubular boiler, to make the bridge wall conform to the shape of the boiler, or to build it straight across? *A.*—If the bridge wall is of brick, we should build it straight across. Sometimes, however, the bridge is a wrought-iron water space communicating with the inside of the boiler. When these water bridges are used, the upper end should conform to the shape of the boiler, so that the ends incline upwards to facilitate the escape of the steam bubbles as they are formed on the inner surface. 2. I was always of the opinion that the area over the bridge wall was governed by the amount of coal consumed, but a friend of mine says it has nothing to do with it. *A.*—The area above the bridge wall depends on the size of grate, strength of draught, character of fuel, thickness of fire, and the relative quantity of air admitted through the bars and above the fire, or behind the bridge itself. As an approximate rule, make this area equal to one sixth of the grate area; it may have to be reduced to one-eighth; the best height between these two limits can be determined only by actual trial.

(459) X. Y., ———, writes: In looking over your back numbers I noticed the answer to Question 353 in your issue of August 18, 1892, relating to strength of beams. I do not understand it, and therefore should be pleased if you will kindly explain it and show how you have obtained the different constants used, and how you have made the reductions of formulas. Please give all particulars. *A.*—The formulas in the answer referred to have been obtained from the fundamental formula employed for computing and investigating the strength of beams, it is as follows:

$$M = \frac{S\,I}{c}. \qquad (1)$$

In which M denotes the bending moment; S the tensile or compressive stress per square inch on the fiber most remote from the neutral surface of the beam; c the distance in inches from the neutral surface to the most remote fiber, and I the moment of inertia of the cross section. This formula is used for computing the strength of beams of any cross-section, either rectangular, round, elliptical, I form, etc. We prefer to use this formula in preference to the ordinary formulas usually given in engineers' pocket-books for rectangular beams because its application is of greater range and the results are more satisfactory. The moment of inertia I for a circle is $\frac{3.1416 \times d^4}{64}$, and the value of c in formula (1) is in this case equal to $\frac{1}{2}\,d$, in which d denotes the diameter of the circle. Substituting in formula (1) for I and c their values as here given we have

$$M = \frac{S \times 3.1416 \times d^4}{64 \times \frac{1}{2} \times d},$$

which reduces to

$$M = \frac{S \times 3.1416 \times d^3}{32}.$$

If we take 50 tons per square inch for S, the ultimate tensile breaking strength of steel, and substitute this value in the last formula, we have

$$M = \frac{50 \times 3.1416 \times d^3}{32}.$$

For a beam loaded at the center and supported at the ends, the bending moment M is equal to $\frac{W \times l}{4}$, in which W denotes the load, and l the length between supports. Hence we have

$$\frac{W \times l}{4} = \frac{50 \times 3\ 1416 \times d^3}{32}$$

from which we get

$$W = 4 \times \frac{50 \times 3.1416 \times d^3}{32 \times l}. \qquad (2)$$

Multiplying 4 by 50 and by 3.1416, and dividing the numerator and denominator by 32, we have

$$W = \frac{19\ 635 \times d^3}{l}$$

as given in the answer referred to. For finding the center breaking load of a square beam supported at the ends we again use formula (1). The moment of inertia I for a square section is $\frac{d^4}{12}$, and the value of c is $\frac{1}{2}\,d$, in which d denotes the length of a side of the square in inches. Substituting these values for I and c in formula (1) we have

$$M = \frac{S \times d^4}{12 \times \frac{1}{2} \times d}$$

which reduces to,

$$M = \frac{S \times d^3}{6}. \qquad (3)$$

Remembering that for a beam supported at both ends, the bending moment is equal to $\frac{W \times l}{4}$, formula (3) may be written,

$$\frac{W \times l}{4} = \frac{S \times d^3}{6},$$

from which we get,

$$W = 4 \times \frac{S \times d^3}{6 \times l}.$$

Taking a value of 50 tons for S, and reducing, we have,

$$W = \frac{33\ 33 \times d^3}{l}$$

as given in the answer referred to. 2. Can these formulas be used for finding the load which any beam made of any material can support? *A.*—Formula (1) can and should be used for finding the strength of any beam, the other formulas are simply a reduction of formula (1) for a particular case. In order to use this formula, all that is needed is to take proper value for I and c, and the safe working tensile or compressive stress for S; all these are given in many of the engineers' pocket books, and books treating on mechanics. Of course, M depends on the manner of loading the beam; for convenience of reference, we give the following formulas for beams of rectangular cross-section and loaded in different ways. All these formulas are derived from formula (1). The moment of inertia I of a rectangular section is $\frac{b\,d^3}{12}$, in which b denotes the base of the rectangle; and d its depth; the value of c in formula (1) is, for this section, equal to $\frac{1}{2}\,d$. Substituting these values for I in formula (1) we have,

$$M = \frac{S \times b \times d^3}{12 \times \frac{1}{2} \times d},$$

which reduces to

$$M = \frac{S \times b \times d^2}{6}.$$

For a cantilever loaded at the end with W, we have

$$M = W\,l; \text{ hence, } W = \frac{S\,b\,d^2}{6\,l}.$$

For a cantilever uniformly loaded with W,

$$M = \frac{W\,l}{2}; \text{ hence, } W = 2\,\frac{S\,b\,d^2}{6\,l}.$$

For a simple beam loaded at the center with W, and supported at the ends,

$$M = \frac{W\,l}{4}; \text{ hence, } W = 4\,\frac{S\,b\,d^2}{6\,l}.$$

For a simple beam loaded uniformly with W, and supported at the ends,

$$M = \frac{W\,l}{8}; \text{ hence, } W = 8\,\frac{S\,b\,d^2}{6\,l}.$$

The following safe-working values for S are generally employed:

For timber	1,000 to 1,200 pounds.
For cast-iron	5,000 to 6,000 pounds.
For wrought-iron	10,000 to 12,000 pounds.
For steel	12,000 to 20,000 pounds.

When S is taken in pounds, the load W will be in pounds. The breadth b, depth d, and length l of the beams are all in inches.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

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"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

A Curious Engine Disaster -Specializing Machine Work.

By W. H. BOOTH.

It is very difficult to provide against the breakdown of machinery, for it is impossible to foresee every cause, and expensive to guard against those which can be foreseen. The addition of complication in all machinery may add to efficiency; it adds likewise to the danger of breakage, if only by reason of adding to the number of parts. But in some cases the additional parts are essential to a different principle in working, which may add to the risk. Take, for example, the system of compound working of steam. One of the English insurance companies which takes risks on steam engines has found out one way in which a compound engine may break down from which a simple engine would be free. The low-pressure eccentric became loose. This is an accident that has happened often, there can be little doubt, not only to simple engines but to compound, but on this special occasion it so happened that the low-pressure slide valve stopped in its middle position, or at least so near to that position, as to blank both the steam ports. With a light fly-wheel there might perhaps have been no accident, but as it was the high-pressure cylinder continued to work, the governor gave it more steam as the speed reduced, and the engine with good fly-wheel ran sufficiently long to pump steam into the low-pressure valve chest until this burst. The insurance company now recommend a safety valve to be fixed between the two cylinders, as is done in compound locomotives.

With an intermediate receiver of a very large size, it is easy to see that the pressure pumped into the low-pressure valve chest could hardly reach to the boiler pressure, as the stored energy in the fly-wheel would expend itself on the ordinary work done by the engine before the boiler pressure could be reached, for the high-pressure cylinder could not by itself pump up so much back pressure. With small receiver room, however, two or three revolutions would be enough to get up a heavy back pressure before the momentum of the fly-wheel was exhausted, as happened in the case in point, and disaster was brought about. The necessity for water-relief valves in cylinders which had piston valves was similarly indicated by a series of breakdowns occurring in such engines, the relief of water being impossible with the piston valve, which cannot be pushed off its face like the ordinary slide. In putting on such water relief valves, however, many of them were made with heavily weighted short levers. Now, when there is water in a cylinder, it has got to move out very quickly, or else it smashes the cylinder. The weight on the lever of the relief valve, like every other weight, resists being put into motion instantaneously. As a result the valve moved and let out the water, but the weight stood still. What, then, did move? The weakest place, of course, which fortunately happened to be the valve lever; this bent under the blow from the water on the valve it pressed upon, and relieved the pressure. Now any one could have foreseen that a weighted valve could not act properly as a water relief, for it could not move fast enough without bending the lever. Natural law indicates a spring-weighted valve for such quick action, because the pressure of a spring may be great, but its mass is small, and can be quickly moved.

I am reminded of this matter of water-relief valves by the above breakdown, and mention it because it is an illustration of an attempt to bring out something differing from an already existing satisfactory spring loaded valve by a firm who had enough to do without this, and could better have purchased all the relief valves they wanted from specialist manufacturers. Manufacturing details of machinery is now so much a matter of specialism that many firms who have their special line of business, and yet feel compelled to supply incidentals, would do far better to purchase the details and do

little more than assemble the parts. To do this successfully should not be difficult, if attention be given to a few of the details in construction.

For example, if a single barrel pump is to be made driven by belt and toothed gears the parts may be made at half a dozen different shops miles apart. One firm makes the crank-shaft, bends it out of the round bar and delivers it turned and keywayed for less than the crank could be rough bent by the pump maker himself. The toothed wheels are made by another firm, the pedestals or shaft bearings are bought off the shelves of a firm who make such things their constant occupation.

A builder of engines, as Mr. Sweet says, will make all the parts in different rooms, and when assembled they will fit. If they were made in different towns there should be no difference. But in every-day work at reasonable prices the work may be perfectly sound and good, and not absolutely accurate. If a bored wheel is to be keyed on a turned shaft the chances are that if the shaft is made in one place, and the wheel in another, the diameter of the 4-inch shaft will be either too great for the 4-inch bore of the wheel, or it will be too small. If too great there will be money spent in filing, and if too small the wheel will really only bear upon the shaft along, theoretically, a mere line at one side and the key opposite. By abandoning any attempt to secure a positive fit of the wheel on the shaft—I mean a sliding fit with no shake—we could order both shaft and bore exactly 4 inches, and probably get them so very much more easily than we could get one of them 4″ and the 4″ plus one one-thousandth, and this gives us an absolute concentric fit of wheel and shaft.

But they could not be put together. To do this a little over half the circumference of the bore is removed, a crescent being bored out by shifting the boring bar say $\frac{1}{16}$″ out of center and reboring with a radius say $2\frac{1}{32}$″. I learned this first from the Porter-Allen engine builders who thus bored their fly-wheels. They fitted the shafts exactly over nearly half the circumference of the shaft on one side and on the key opposite and are yet removable easily which can never be the case with an ordinary bored fit, and yet after all the cutting out of the crescent bit only enlarges what is a gap even in the best keyed wheel unless a shrunk fit has been made. It seems to me that by attention to various points such as this many firms who cannot find full employment for the machinery they would require to do good work can yet provide quite large with advantage, and I have seen where great inconvenience and loss have ensued from the attempt to do work for which a shop was not fitted, and which has quite disjointed the legitimate course of work in such shop.

It is often the case that those most interested do not see the advantage of the system, and I know of a recent case where a piece costing sixty dollars in the rough casting was obtained elsewhere bored, turned and of better quality for fifty dollars, and this was looked upon as wrong to the machinists who did not have to do the turning. But half the people in this world cannot see beyond their noses. And yet these same machinists had more legitimate work in hand than they could get through; they were grumbling, did they know it, at the doubling of the capacity of the shop without increasing capital to be lying idle in less busy times. The above remarks are prompted originally by my knowledge of the difficulty found by the engineers of manufacturing establishments in obtaining reasonable tenders for work because of some fancied difficulty in its erection. The engineer can order his materials and put them together himself, if he feels sure that the difficulties have been overrated by the contractors.

Graphical Determinations of Weights of Fly-wheels of Steam Engines.—II.

By Emil Theiss.

For driving engines we may in general regard the crank effort due to the resistance as constant, so that the curve representing it will be a straight line parallel to the axis of abscissæ. The ordinate w locating this parallel is readily found, when we remember that the work due to the resistance must be for each revolution equal to the work done by the power, which is measured by twice the area of the indicator diagram $= 2\ f$. The work due to the resistance is expressed by $w \times s \times \pi$, so that $w = \frac{2f}{3 \times \pi}$. Accordingly, we find in Fig. 7 lines of resistance drawn full, with dot and dash, and dotted, to correspond with the different degrees of compression adopted. The weight of the fly-wheel is a function of the deviation between the crank effort curves of power and resistance. It may be proved that for four points of intersection of these curves for one revolution, the weight W or mass M of the fly-wheel is directly proportional to the greatest of the areas, F, intercepted between the curves of power and resistance, so that we have:

$$F = \tfrac{1}{2}\,\frac{W}{g}\left(V^2_{max.} - V^2_{min.}\right) \qquad (3)$$

When there are more than four points of intersection, we proceed by finding where the algebraic sum of successive intercepted areas attains a maximum and a minimum. The sum of these two values is to be used in place of F in (3). Equation (3) may be written:

$$F = \tfrac{1}{2}\,\frac{W}{g}\Big((V_{max.} + V_{min.})\,(V_{max.} - V_{min.})\Big)$$

From (1) we have:

$$V_{max.} - V_{min.} = \frac{V}{d};$$

also

$$V_{max.} + V_{min.} = 2\ V,$$

so that

$$F = \tfrac{1}{2}\,\frac{W}{g} \times 2\ V \times \frac{V}{d} = \frac{W}{g}\,\frac{V^2}{d}.$$

Hence

$$\frac{W}{g} = 32.2\,\frac{d}{V^2}\,F.$$

If we represent the area equivalent to the work due to the resistance reduced to the crank-pin ($w \times s \times \pi$) by F_0, we may write:

$$W = 32.2\,\frac{d}{V^2}\left(\frac{F}{F_0}\right) \times F_0 \qquad (4)$$

Let the I. H. P. of the engine be N, the number of revolutions being n, then

$$N = \frac{w \times s \times \pi \times n}{33{,}000} \qquad (5)$$

and

$$w \times s \times \pi = 33{,}000 \times \frac{N}{n} = F_0.$$

Substituting this value of F_0 into (4),

$$W = 32.2 \times 33{,}000\,\frac{d \times N}{V^2 \times n} \times \frac{F}{F_0} = 1{,}002{,}600\,\frac{F}{F_0} \times \frac{d\,N}{V^2\,n} = i \times \frac{d \times N}{V^2 \times n} \qquad (6)$$

Where $i\ \left(= 1{,}002{,}600\ \frac{F}{F_0}\right)$ is the coefficient of the fly-wheel, which may be calculated from the areas F and F_0. F is found either by calculation or planimeter; F_0 is found by planimeter. In finding F_0, a valuable check is furnished by the fact that the sum of the areas by which the resistance is in excess of the power must for each period or revolution be equal to the areas by which it falls below. If the sum of these areas is not the same, the error, *i. e.*, the difference between them, should be distributed among the different intercepted areas in proportion to their magnitude. Coefficients arrived at as indicated are given in Table I for

I.—Single Cylinder Non-condensing Engines.

Weight of fly-wheel in pounds, $W = i \times \frac{d\,N}{V^2 \times n}$; where d is the coefficient of steadiness, N the I. H. P. of the engine, V the mean velocity of the fly-wheel rim in feet per second, n the number of revolutions per minute, $i = 1{,}002{,}600\ \frac{F}{F_0}$ found from the diagrams.

From this table the influence upon the coefficient i and the weight of the fly-wheel, which is proportional to it, of cut-off, piston speed and compression is at once apparent. It is equally evident from the crank effort curves. These latter present, in the first place, a marked difference for the inward and outward strokes. As the cut-off is increased, the curves are flattened, *i. e.*, approach more nearly the curve of resistance, with a corresponding diminution of the weight of the fly-wheel. For the same cut off, increasing piston speed has a tendency to flatten the curves; high speeds have, therefore, a regulating effect. Here, however, we reach a limit at about 800 feet piston speed; as for speeds beyond this limit the rise of the curves toward the end of the outward stroke more than outbalances the equalizing tendency throughout the remainder of the period. This speed is seen to be greater than that which makes the tangent to the curve for the second half of this stroke a horizontal line, which is sometimes regarded as the best speed for regularity of running. It is apparent from Fig. 3 that, of the areas intercepted between the curves of power and resistance, the greatest is among those by which the power falls below the resistance. These latter increase with increase of compression. The higher therefore compression is carried, the heavier will the fly-wheel have to be for a given coefficient of steadiness.

Condensing engines were treated in the same way. The following general assumptions were made: The terminal pressure was taken as 7½ pounds, the back pressure 4 pounds, clearance 4 per cent. The cut-off varied from $\frac{1}{16}$ to $\frac{1}{2}$ of the stroke, and compression was carried as before, to the initial pressure, p, to 0.7 p, and 0, *i. e.*, there was no compression. The weight of reciprocating parts is to be taken greater than for non condensing engines by the weight of the pump connections. $G = \frac{5}{4}\,G_n$, where G_n is the weight for the same engine, non-condensing.

Equation (2), the expression for the pressure due to the acceleration of the weight of reciprocating parts, then becomes:

$$q = .28\ v^2\ [cos.\ a \pm \tfrac{1}{5}\ cos.\ 2\ a] \qquad (2\ b)$$

This expression was used for plotting the curves for piston speeds of 200, 400 and 600 feet per minute.

In this case, for the higher velocities the lines of resistance and the power curves intersect in more than four points, and the general method comes into application. Table II gives the coefficients.

II.—Single Cylinder Condensing Engines.

Weight of fly-wheel $W = i \times \frac{d\,N}{V^2\,n}$; $i = 1{,}002{,}600\ \frac{F}{F_0}$.

The greatest area intercepted was again found among the areas showing deficiency of power, and for piston speeds to 400 feet it came into use in determining the ratio $\frac{F}{F_0}$. For a piston speed of 600 feet, the general method mentioned above became applicable.

The diagrams of single cylinder non-condensing engines were used for examining into the working of *two-cylinder engines with cranks at* 90°. The ordinates for the crank effort curves were obtained by combining two sets of curves shifted relatively to each other by a distance $= \frac{s\,\pi}{2}$.

From the diagrams so constructed, values of i were calculated for no compression, and for compression to the initial pressure.

III.—Two Cylinder Engines, Cranks at 90°.

Weight of fly-wheel $W = i \times \frac{d\,N}{V^2\,n}$; $i = 1{,}002{,}600\ \frac{F}{F_0}$.

From Table III we see at once that, for the same cut-off and degree of compression, but varying piston speeds, the coefficients change very little; which means that, for this class of engines, piston speed has no influence on the regularity of running. It is evident why this should be so. The

I.—Values of i.

Piston speed feet per minute.	Cut-off ⅛			¼			⅜			½		
	Compression.											
	p	$.7\,p$	o	p	$.7\,p$	o	p	$.7\,p$	o	p	$.7\,p$	o
200	272,690	241,580	218,580	242,010	220,280	209,170	220,760	207,230	201,920	193,340	187,670	182,840
400	240,810	209,890	187,480	208,200	188,880	179,460	188,510	176,080	170,040	174,630	167,860	167,860
600	194,670	165,450	145,400	168,590	151,440	136,460	165,210	150,710	146,610	.....	.....	.....
800	158,200	132,020	108,690	162,070	148,540	135,260	.....	.....	.....	.....	.....	.....

II.—Values of i.

Piston speed.	Cut-off $\frac{1}{16}$			⅛			¼			⅜			½			⅝			¾		
	Compression to																				
	p	$.7\,p$	o	p	$.7\,p$	o	p	$.7\,p$	o	p	$.7\,p$	o	p	$.7\,p$	o	p	$.7\,p$	o	p	$.7\,p$	o
200	292,730	241,770	180,180	265,560	226,310	176,560	234,160	206,030	173,660	217,980	195,400	171,000	204,210	185,250	167,140	189,600	173,900	161,830	172,690	165,980	156,960
400	212,910	171,970	117,380	194,550	163,030	117,870	174,380	151,680	118,350	166,290	146,610	121,730	164,720	148,780	133,080	174,630	164,970	151,680	.....	.....	.....
600	141,900	127,590	124,630	148,780	143,710	140,090	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

III.—VALUES OF i.

Piston Speed.	Cut-off ⅛		¼		⅓		½	
	COMPRESSION TO							
	p	o	p	o	p	o	p	o
200	71,980	60,140	59,420	54,340	49,272	50,000	37,920	36,950
400	70,160		57,000		49,150		35,500	
600	70,040		57,480		49,220		36,710	
800	70,040		60,140					
	mean 70,560		mean 58,510		mean 49,210		mean 36,710	

pressure due to the acceleration of the reciprocating parts for the single cylinder engine is a maximum when the crank is at the dead points; while for the two-cylinder engine it is almost zero. For other crank positions the algebraic sums of the ordinates are almost constant, so that their influence on the crank effort curves is insignificant. The influence of compression, also, is of less importance, and disappears when the cut-off is long.

In a similar manner diagrams were constructed for *three-cylinder engines with cranks at angles of* 120°. They were obtained by the combination of the ordinates of diagrams of three single cylinder engines shifted relatively to one another a distance $= \frac{s\ \pi}{3}$.

Table IV gives coefficients for the case under consideration.

IV.—THREE CYLINDER ENGINES, CRANKS AT 120°.

Weight of fly-wheel $W = i \times \frac{d}{V_2} \frac{N}{n}$;

$i = 1{,}002{,}600\ \frac{F}{F_0}$.

IV.—VALUES OF i.

Piston Speed.	Cut-off ⅛		¼		⅓		½	
	COMPRESSION.							
	p	o	p	o	p	o	p	o
200	33,810	32,240	33,810	35,500	34,540	33,450	35,260	32,370
800	30,190	31,570	35,140	33,810	36,470	32,850	34,810	32,370

It is evident that the influence exercised by variation of piston speed, cut off, and compression is of little moment. The coefficients differ but little, and constructions for intermediate piston speeds and degrees of compression are superfluous.

As a mean value of i for these engines we may use 33,810.

Two and three-cylinder compound engines may be examined in the same general way. The problem is, however, rendered complicated by new factors, such as size of receivers, distribution of work among the different cylinders, etc., and the general nature of the simplifying assumptions necessary for a solution would vitiate the results as applied to special cases. Characteristic cases may be picked out, but, in general, it will be best to go through the operation of construction and calculation for each engine.

In all the cases considered cut-off and compression were taken to be equalized for both strokes. This it is, owing to the irregularities introduced by the connecting-rod, impossible to accomplish in practice without inequality in the steam and exhaust leads. To examine into the extent of the differences, diagrams were constructed for equal cut-off (⅓ stroke) and compression at both ends to initial pressure, and also for diagrams with the same *mean* cut-off and compression, but with leads equalized. For length of connecting-rod equal to five cranks, this resulted in a difference of the cut-off of 9 per cent., and of the compression at the two ends of 4½ per cent. of the stroke. The piston speeds ranged, as before, from 200 to 800. For equal cut-off and compression the area intercepted between the curves of power and resistance, that is, the pressure of the weight of fly-wheel, was found among those showing excess of resistance over power, while for equal leads this intercept was found among those showing excess of power. For all the piston speeds examined this latter exceeded the former, the differences increasing rapidly with the piston speed.

These differences expressed in per cent. of the greater areas were for

$v = 200$ feet per minute.....11.3%
$v = 400$ " " " 13.4%
$v = 600$ " " " 19.5%
$v = 800$ " " " 24.3%

The same figures express likewise the difference in the weights of fly-wheels. We may therefore express it as a general rule, that the greater the piston speed, the more desirable it will be to adjust the valve for equal cut-off and compression, rather than for equal leads, as being conducive to greater regularity of running. Where there is but one valve, we can indeed, by making the steam and exhaust laps to suit, equalize cut off and compression, but only at the expense of great inequality of lead, release and port opening; the best we can do is to compromise. Where there is a separate cut-off valve, however, the main valve may be set so as to equalize the lead and to give approximately equal release and compression, while the cut-off valve may be set to equalize the cut-off, at any rate for the ratio of expansion commonly used.

For poppet valve engines, or engines of the Corliss type, with four independent valves, all conditions necessary for smooth running may be observed in their setting. However, for this class of engines, the importance of the considerations under discussion is lessened by the lower piston speeds employed.

Making Wheels in Halves.

BY P. S. DINGEY.

A very common practice in making large wheels is to cast them in halves by setting a cast-iron plate, or a core in the mold, cutting the hub entirely through, and the rim partially, leaving sufficient metal on the outside to form a bearing surface after it is broken and bolted together.

This method of putting together large wheels of any kind cannot be considered first-class, and while it may be good enough for some wheels, for others it is not. A better way is to allow stock on one side of the center line of each half of the wheel to permit of planing the joint; that is, to make the wheel larger in diameter one way than the other, or the joint may be planed without allowing any stock for so doing, in which case plates to go between the joint are planed to a thickness corresponding to the amount taken off both halves, and doweled on the surface of joint, but this does not give such a satisfactory job as making the two parts of the wheels a little over the center line, as already stated.

Gear wheels which are to be in halves should never, in my opinion, be bolted together with a break joint, though this is often done, and, in making this statement, I am probably running against many who think otherwise.

It may be argued that to make a wheel in halves with a break joint is a much quicker way, and, therefore, costs less than with a planed joint. It *is* a much quicker method, but whether it costs less in the end is a question, for sometimes a break joint in a wheel, and especially a gear wheel, gives considerable trouble after it has been running for a short time. The grain of the iron in large wheels is not usually very close, but is what foundrymen call "open," and the coarse particles of iron in breaking are torn asunder in a way that it is almost impossible to bolt the joint together twice alike, or to have a solid bearing, because the particles do not fit perfectly into the small recesses from which they have been torn; the result is that the joint chafes and becomes loose after working awhile, and when tightened up will make the wheel run out sidewise.

To make a gear wheel in halves with a segment pattern, as represented in Fig. 190, with stock on the joint for planing, requires care and skill on the part of the molder; with a gear molding machine, the machine does the spacing, but in this case the molder and pattern maker are partners, and are together responsible for the correct spacing of the teeth, and with care a gear can be made with a segment pattern that for a cast gear will be practically correct.

The pattern of the segment is built up in six courses, and in doing so every other course is cut in two. The usual way that pattern makers have in building up a large segment pattern of this kind, is to glue all the segments together, with the grain of the wood running one way; the result is that after a time the pattern springs out from the original circle it was worked to. A pattern maker would not think of building up a whole circle this way, neither should he a segment pattern that has to be kept to a certain arc like a gear segment. The thing to do after cutting every other course n two pieces, is to turn the two parts "end for end," as they say in the shop; this will keep the pattern from warping or springing out of shape if the stuff is dry—it will not be so well for working off when built as I have said it should be, but it will be right when done, which is the most important.

The radius pieces are let in flush with the top of the pattern, so that they do not interfere with the molder when he is leveling and sleeking off the top of the mold around the teeth. It is not customary to let these pieces in as shown; but I think it better to do so, for the reason just given. On the end is an iron plate D that fits against the spindle; this plate has four slot holes in it for adjusting the segment pattern to the correct diameter.

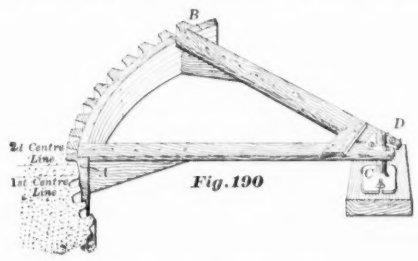

Fig. 190

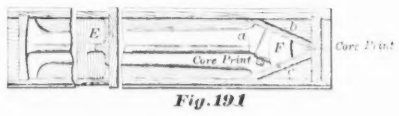

Fig. 191

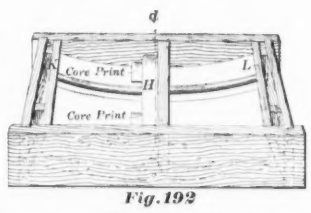

Fig. 192

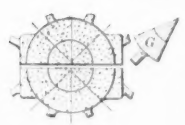
Fig. 193

MAKING WHEELS IN HALVES.

Referring to Fig. 190, it will be seen that a part of the segment on each end is plain, having two lines A and B marked on the upper edge; these lines are the centers of spaces between the teeth. It is desired to make the wheel 1½" larger in diameter one way than the other; this will allow ½" for planing the joint, and for splitting cores 1" thick. In this case it is best to use cores for splitting, in preference to cast iron plates, as the iron plates would chill the surface to be planed, making it hard, and thus causing the planer hand trouble. Suppose this gear to have 96 teeth. After 48 or one-half of the teeth have been formed, two center lines 1½" apart should be made on the top of the mold, as shown, representing the joint of casting after it has been planed. Now by moving the spindle 1½" at right angles to these lines, and setting the line A marked on the pattern to the second center line, it will give the necessary space between the teeth next the joint, allowing for 1" splitting core, and ½" for planing.

It will be noticed that on the end of the spindle is a square base C, into which two holes are cast for bolting it to a timber. These holes are slotted, enabling the molder to move the center as described. The spindle is cored out like a pipe, and if bored a little tapering may be used as a socket for an ordinary spindle to work in. Such a spindle will be found a very handy, though simple, rig for making wheels in halves, when joints have to be planed.

I have said that the hub is cut entirely through; this should always be done, whether the halves are to be planed or not, as it relieves the shrinking strain in the arms and rim.

The inside of the rim and the arms of the wheel are formed with cores. Boxes from which these cores are made as shown in Figs. 191 and 192. A half section of the arm, which is a cross shape section, is seen at E, and as in the case of oval section arms, a core box for one-half of the arm is all that is required There are three loose pieces fitted in the end of the box to form the hub, one marked F, another the opposite hand to F, and the plain piece marked G shown outside the arm box. Each of these pieces matches the rib of arm at a. The two short sides b and c of the box are set ¼" back from the radial line, or where the cores join, and two loose pieces ¼" thick fitted in, to bring the sides to the radial line. The object of this is to give ¼" stock on the hub for planing.

When F is used, the ¼" piece on side b is left out, while the one on side c remains in, and when the opposite part to F is used, then the ¼" piece on side c is left out, and the one for side b is put in. When G is used, then the ¼" pieces go in on both sides.

There being eight arms to this gear wheel, there will be four cores each, when using F and the piece which is the opposite hand to F, and eight with G, making sixteen for the bottom and top.

When these arm cores are located inside the mold, whose diameter, it will be remembered, is made 1½" longer one way than the other, the cores at the hub will be 1" apart, as seen in Fig. 193; this space will receive the splitting core after the two half-round cores for the bore have been set in place.

The core box, from which the cores are made to form the inside of the rim between the arms, is shown in Fig. 192. H is the lug for bolting the wheel together at the rim, and is taken out after making four short cores. These cores, of course, are located in the mold, so that the lugs correspond with split in the hub, and when set will leave a space to receive the splitting core in the same way as the arm cores at the center in Fig. 193. The lug H being set ¼" past the center line d shows the stock that is allowed for planing the joint.

The two ends L and K of this box run under, making a "back draft," as represented by dotted lines on the side; they are made thus, so that the ends of cores may fit against the sides of the arm cores. These ends being "back draft" are, therefore, made loose, in order that the cores may leave the box without taking it apart—the ends come out with the core.

That part of the rim at the lugs is not cut into by the splitting cores; the rim is, therefore, the full thickness at that point. This is done to prevent the wheel from breaking at the joint, and the ends from springing away from the center lines while shrinking, and that the casting might remain intact for testing and laying out the two center lines.

Having recently made two gears 10 feet 2½" diameter, 4" pitch, 12" face, in the manner described here, I had some misgiving that the rims might spring after they had been cut in two, causing the teeth next the joint to be out of place, but they did not, and after they were planed and bolted together the spaces between the teeth at the joint did not vary from the others. The wheels also were practically true, thus showing that with extra care on the part of molder and pattern maker, a good job may be done in making gears this way and without the

gear molding machine. I do not mean by this to depreciate in any way gear molding machines, but then they are not on hand in most shops when needed.

Lightning Conductors.

In a letter to *Engineering* (London) Mr. J. B. Breuer, Engineer, R. A., Berlin, relates an accident, and the means employed to prevent a recurrence of the same, which may give a useful hint to some of our readers:

"An accident which took place a short time ago in one of the large Silesian foundries, and which almost proved of disastrous consequences, has induced the owners of the Carls Works, in Bunzlau, Silesia, Germany, to make a rather ingenious invention, to which public attention ought to be turned, the question being of importance.

"Some time ago the heavy iron bar at the upper end of the lightning conductor of one of the high chimneys in the foundry, fell from its considerable height, and caused great damage. The reason was that the vapors escaping from the mouth of the chimney had completely destroyed the lower part of the iron bar. In another case, where the bar was of copper, the lower part became completely oxidized, and the bar bent over and fell. Owing to the ever-varying composition of the coal, containing, for instance, greater or smaller quantities of pyrites, and developing therefrom sulphurous acid by combustion, there must always be danger of complete oxidation and falling down of the lightning bar. The question is now, how to stop this inconvenience?

"The Carls Works, Bunzlau, in Silesia, Germany, have met the case in the following ingenious way: The metal bar being, as a rule, about 4 feet in length and 1 inch in diameter, is surrounded or inclosed by a system of glass tubes of a special form. The interval between metal and glass is filled up by a special kind of cement. The upper end of the highest tube is covered hermetically by a small conical glass, allowing only the platinum point of the bar to project.

"The advantage of the construction is obvious. The glass is not susceptible to the influence of atmospheric or chemical influence. But there is still a second point worthy of consideration. As a matter of fact, any metal will lose more or less its quality of conducting electricity by oxidation of even only its surface; thus in time the whole lightning conductor may become useless. To prevent even the slighest oxidation the above apparatus is suitable. So the Carls Works, system as described, will prove of the greatest advantage for protecting lightning conductors, whether on high chimneys, houses or any other buildings."

Some Nonsense.

A new paper called *The Paterson Machinists' Journal* has been started at Paterson, N. J. It pays little or no attention to technical matters, but devotes its space mainly to social and economic affairs, regarding which it seems to us it is a little cloudy. For instance, it prints the following:

The *Twentieth Century* makes a good point when it says: "A thirty-ton electric locomotive has been completed at the Lynn (Mass.) shops of the General Electric Company. Its normal speed is thirty miles an hour, with capacity far greater. Were we living under a co operative commonwealth every skilled machinist that could be spared from other lines of industry would be set at work turning out electric locomotives until every railroad was provided, and the old steam engines were melted over. There is wasted energy in the tides, in the waterfalls and mountain streams that properly harnessed would provide the power. Yet the blighting hand of private ownership and private monopoly holds back the tide of progress, and idle men starve in the land where all could have plenty."

Now it seems to us that a man sufficiently acquainted with machinery to be capable of editing a paper for machinists ought to know that this item is not only without a good point, but that it contains no point whatever.

Any machinist worthy of the name ought to know that the simple fact that an electric motor had been constructed to run thirty or any other number of miles an hour, proves just nothing at all as to its superiority over the steam locomotive for actual service, unless the comparative cost of equipment, economy of operation, reliability and cost of maintenance be also taken into account.

It ought also to be plain that as soon as it can be shown that the electric motor is superior to the steam locomotive in these respects, enough skilled machinists would be very promptly "spared from other lines of industry" to construct them, and that neither "the blighting hand of private ownership" nor "private monopoly" would stand in the way. Under a system which allows competition its full effect, the transference of skilled machinists and other workmen from one line of work to another is, in a sense, autonomic, and takes place in exact accordance with natural laws, the superior machine displacing the inferior one.

No scheme for a co-operative commonwealth can ever include a management of these affairs that will work as well.

Then, too, the reference to the forces which "properly harnessed" would afford the power, is mainly bosh. Whenever the harness can be made to cost less than power derived from coal, these sources of power will be used and not before.

MANUFACTURES.

William Davis will immediately rebuild his saw-mill, at Sturgis, Ky.

The machinery for the paper mill at Fort Scott, Kan., has been set up.

Querbach & Smith are erecting a large lumber-mill at Riverside, Ark.

A. G. Ellis is establishing a new saw-mill plant at St. Francis, Lubec.

The capacity of the Interlaken Mills, Fiskeville, R. I., will be increased.

Work will soon commence on the Carolina Cotton-mill, Newton, N. C.

An electric lighting plant will be established at New Westminster, B. C.

H. I. and A. J. Asher will erect a large lumber-mill, at Barbourville, Ky.

Harmon Richardson will erect a 20x50 cabinet shop, at Chelmsford, Mass.

J. T. Gordon will construct a large grain elevator at Pilot Mound, Man.

Edwards & Son will rebuild their Diamond Bottle Works in Knoxville, Tenn.

Strayer & Tripplett will erect a large planing-mill plant at South Akron, O.

The Milo and Seneca paper mills, near Penn Yan, N. Y., are undergoing repairs.

J. A. Peterkin will rebuild his recently-burned shingle-mill at Fort Matte, S. C.

A large new engine is being set up in the West End Rolling-mill at Lebanon, Pa.

A lot of new machinery is being set up in the thread manufactory in Westerly.

The Cowpens (South Carolina) Manufacturing Co. is building an addition to its mill.

Walker & Carson will establish at Carman, Man., a large flouring and oatmeal mill.

It is stated that M. Garland will establish a large machine plant in New Orleans, La.

The Portland (Me.) Steam Packet Company will add to its equipment a new steamer.

William Engleholm, of Chicago, is interested in a proposed tannery at Grove City, Minn.

The People's Mills Plant at Guelph, Ont., are being enlarged and new machinery added.

The manufacture of wall paper on a large scale will be undertaken at May's Landing, N. J.

Sparkman's burned planing mill, at Camden, Dallas County, Ark., will be rebuilt at once.

The Union Pacific Railway Company will build a 17 stall brick roundhouse at Starbuck, Wash.

The Lyons Milling Company will rebuild its plant, recently destroyed by fire, at Bower Mills, Mo.

The Reading (Mich.) Robe and Tanning Company's plant will be extensively enlarged soon.

A large boiler will be set up in the Chick Bros.' shoe manufactory at Haverhill, Mass., this fall.

Jackson Brothers, of Toronto, will establish the manufacture of mowers at St. Catherine's, Ont.

The copper smithing department of the Bath Iron Works, Maine, is being extensively enlarged.

The newly-incorporated Harrington, Son & Co. will erect a large machine plant at Philadelphia, Pa.

The Hamden Glazed Paper and Card Co. will begin on an addition to its South Holyoke (Mass.) mill.

J. W. Williams, of London, Ontario, is interested in a proposed new tannery at Portage La Prairie, Man.

The Wakefield & Stoneham Street Railway Company will erect a new car house at Wakefield, Mass.

The McKinney (Tex.) Wharf Company is a new $25,000 concern, to erect a large cotton-handling wharf.

The Walker Manufacturing Co., St. Louis, Mo., has increased its capital stock from $30,000 to $60,000.

Baker & Company will build a new box manufactory to replace the one recently burned at Worcester, Mass.

The Hunt Manufacturing Company will establish at Westboro, Mass., a 40x104 foot bicycle saddle manufactory.

W. H. Wilmarth & Co. are establishing their jewelry business in their new manufactory at Attleboro, Mass.

Gantt & Ray have built a new mill building at Pocahontas, Tex., and equipped it with a new outfit of machinery.

Many repairs and alterations are being made about the large cotton-mill in Rogerson's Village, near Uxbridge, Mass.

The burned Stubbs' manufactory at Framingham Centre, Mass., is being rebuilt, and will resume the shoe business.

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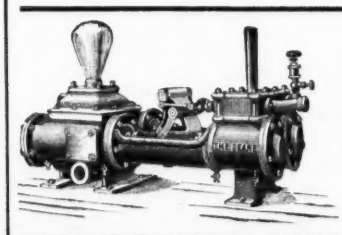
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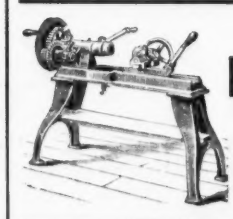
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C. Atwood and D. McLaren have incorporated the Atwood Electric Headlight Co., St. Louis, Mo., with a capital stock of $125,000.

Jerome B. Desnoyers and Charles L. Wallace, of Macon, Mo., have incorporated the Desnoyers Shoe Co., with a capital stock of $65,000.

The Rhode Island Locomotive Works, of Providence, will build eight large engines for the Boston & Maine Railroad Company.

The Record Foundry and Machine Company has commenced the enlargement of the molding department at its plant, at Moncton, N. B.

The Edge Moor (Del.) Bridge Works will soon begin the work of erecting a 170 foot span bridge for the Great Northern, at Kettle River, Minn.

The Keystone Lock Works, of Lancaster, Pa., has just completed an addition to its brass and bronze foundry, 60x42 feet, adding eight new furnaces.

The Toledo Bridge Company, of Toledo, O., is putting up a 90x250-foot addition to its plant, which will be equipped with machinery for structural iron work.

Joseph E. Simms, of Charleston, W. Va., will erect at once a plant for the manufacture of his patent self-locking nuts. About 50 men will be given employment.

The foundry and machine shops at Woodstock, Ala., which have been idle for a number of years, will shortly be reopened by a joint stock company, with a capital stock of $25,000.

Klug, Bacher & Stoll, of Milwaukee, Wis., will soon begin the erection of a brass foundry, 40x80 feet, with a brass finishing shop 40x100, and a pattern shop and boiler room 30x62 feet.

The County Commissioners, of Allentown, Pa., have awarded the contract for the superstructure of an iron bridge over a branch of the Saucon Creek to the Allentown Rolling-mills.

The Gibson Iron Works, at Gibson City, Ill., recently incorporated, will, next fall, erect two buildings, for the manufacture of hot water and steam radiators for general machinery work.

The Nova Scotia Steel and Forge Company, New Glasgow, Nova Scotia, is making extensive additions to its works. A boiler plate-mill is contemplated, and it is probable that a sheet mill will follow.

Mr. George P. Clark, of Windsor Locks, Conn., manufacturer of trucks, has recently erected a new factory 80x40, and has considerably increased his facilities for business by the addition of new machinery.

The bridge to be built across the Arkansas River at Little Rock, Ark., will be 1,680½ feet long, and consist of 6 spans. Included in the work will be a wall of masonry 100 feet long, 294 feet of iron trestle, and a channel span of 360 feet.

The Thomas-Roberts-Stevenson Company, of Philadelphia, Pa., stove manufacturers, has contracted for the erection of a one story brick foundry, 47x100 feet, and a three story brick storage house, 33x66 feet, as an addition to its plant.

F. H. Crafts, of Buffalo, N. Y., has applied his multiple belt driving arrangement to a plain milling machine, the machine in other respects being like the one built by the Cincinnati Milling Machine Co., and illustrated in our issue of March 3, 1892.

The new drawbridge at Flushing, L. I., is fast approaching completion, as the Berlin Iron Bridge Co., of East Berlin, Conn., who have the contract for building the bridge, have a large force of men employed finishing the draw.

The Portland (Me.) Foundry and Machine Works have purchased the foundry stock of the Dirigo Heater Company of that city. The Dirigo Heater Company have given up foundry work as a specialty and will confine themselves solely to turning out their special branch in the heating line.

The Hauson & Van Winkle Co., of 219-221 Market street, Newark, N. J., have issued a catalogue describing and illustrating their new "bicycle-power" plating dynamo. This is a small dynamo which is mounted at the top of a suitable column, which also supports a driving wheel provided with cranks and pedals and a saddle for the operator. Polishing wheels can also be placed upon the spindle. It is intended for the use of jewelers, bicycle repairers, and others who have small amounts of plating to do.

Swain & Reed, Roxbury, Me., have recently built an extension to their birch-mill, adding 2,500 feet floor space, and making in all 5,500 square feet. This is a model dowel mill, being connected with sawing, steam drying and turning room all on the same floor. This mill is 110 feet on the front, has an iron roof, and is run by a 50 H. P. Buckeye automatic engine. The location is in the famous Swift River Valley, eight miles from Rumford Falls, the terminus of the Portland & Rumford Falls Railroad.

The Kilbourn Knitting Company, of New Brunswick, N. J., is removing its entire plant to Martinsburg, W. Va., where it has a branch factory. The removal is brought about by the inducements offered to the company by the authorities of Martinsburg. It had been the intention of the company to enlarge its New Brunswick factory. Land had been purchased, plans had been made, and the contract for the work drawn up, when the Martinsburg people offered it a large tract of land if it would remove to that place, and promised to invest heavily in the concern, besides relieving it of taxation for a term of years. These offers induced the company to remove.

The finest catalogue of machinery that has been issued for some time is that of Bement, Miles & Co., of Philadelphia, Pa., this curiously enough being the first catalogue ever issued by this firm. The present catalogue contains 358 pages and is a finely bound book 10″x12½″, the illustrations, paper, press-work and binding being of a high order. Large and fine illustrations of a complete line of machine tools are presented, though by no means all the different machines built by the firm are shown. There are also exterior and interior

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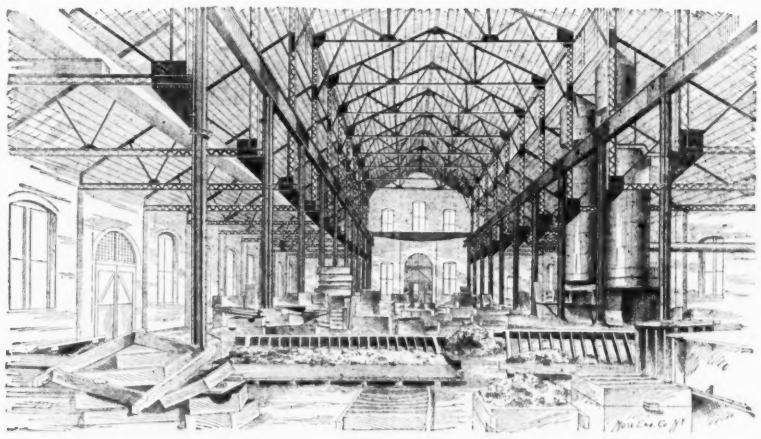
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

Engineers, Architects and Builders of



Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph and shows the interior of a Foundry, the frame-work of which was designed and built by us for The Brooks Locomotive Works, at Dunkirk, N. Y. The building is 100 feet in width and 225 feet in length, the central portion being controlled by a Traveling Crane.

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Friction Pulleys, Clutches and Elevators,
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IRON WORKING TOOLS.
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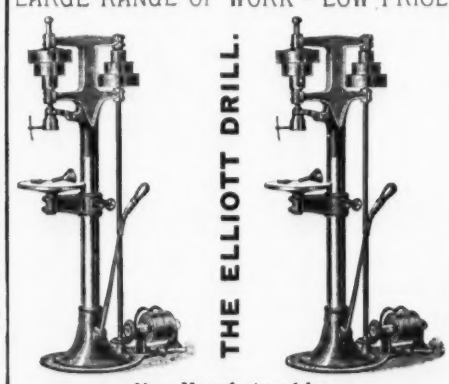

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REDUCED PRICE OF LE COUNT'S
HEAVY STEEL DOG

This Dog has a Very Heavy Boss, so that if the thread wears a Heavier Screw can be substituted.

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11	1 3-4	1.10
12	2	1.20
13	2 1-4	1.35
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19	5	3.25
Full set of 19		$21.60
20 (ext.)	5 1-2	4.00
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Le Count's Heavy Steel Dog.
With Steel Screws, Lathe Made and Hardened.
When ordering, state as above, whether a full set or a set of 12, or small set of 8. (Sets of these dogs prefer them to any other make).
One Small Set of 8—by 1-4 inches to 20 inch, - - $6.25
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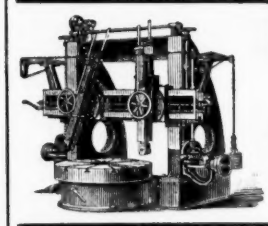
These goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.



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14 SIZES FROM 5 TO 20 FEET.
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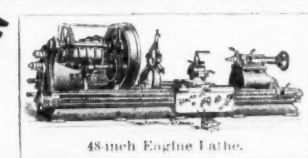
48-inch Engine Lathe.

ENGINE LATHE
METAL-WORKING MACHINES
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BORING AND TURNING MILLS.
37, 51 and 62 Inch Swing, with Two Regular Heads.
42 INCH SWING, WITH TURRET HEAD, AND SCREW CUTTING ATTACHMENT.
All gears accurately cut. All feeds positive.
Machines are self-contained and therefore do not require an expensive foundation.
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New York Office, 39 CORTLANDT STREET, ROOM 86.

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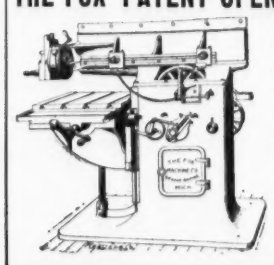

No springing of ram. No overhanging to fix. Quick Return, Stroke Under Perfect Control. Can be Instantly Adjusted 1 16 in. or 24 in. No Screws to Monkey with. Powerful, Quick, Accurate. Write for circular.
THE FOX MACHINE CO., 325 N. Front St., Grand Rapids, Mich. Chicago Office, Machinery Hall Annex, Section 13, Column J 43, World's Columbian Exposition. 125 Finsbury Pavement, London, England.

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Machinists & Tool Makers,
Punch & Die Work & Tool Making of all descriptions.
ESTIMATES FURNISHED.
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ONLY APPARATUS that can MAINTAIN a VACUUM on ENGINES and ELEVATE the discharge WATER to TANK at any height.
This feature is appreciated by PAPER MILLS, SUGAR REFINERIES, COTTON and WOOLEN MILLS.
HENRY R. WORTHINGTON,
NEW YORK,
BOSTON, PHILADELPHIA, CHICAGO, ST. LOUIS, DENVER.

views of the shops, with a description of their facilities, all presented in language which evidently aims to understate rather than overstate. Those who are interested in machine tools will consider themselves fortunate in the possession of a copy of this catalogue.

The Tradesman, Chattanooga, Tenn., in its review of the industrial situation in the South for the week ending September 4th, reports a slight revival in business, and that the signs indicate that the South is slowly recovering from the effects of the recent critical period. There have been no failures of importance, the banks are resuming payments in the larger cities, and the coming in of the cotton crop is giving some animation in business circles. Several of the larger cotton-mills which either shut down or ran on reduced time have resumed in full force. The cyclone of the last week has seriously affected the production of sea island cotton and of naval stores, and the crop will be much reduced. Cotton will not come to market in large quantities unless the price advances, as the farmers are generally in shape to hold it, and will not sell for the cost of production alone. *The Tradesman* reports twenty-eight new industries as established or incorporated during the week, together with eight enlargements of manufactories and eleven important new buildings.

Machinists' Supplies and Iron.

NEW YORK, September 9, 1893.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $14.50 to $15.00; No. 2, $13.50 to $14.25; Gray Forge, $12.25 to $12.50. Southern brands of good quality are obtainable at $13.75 to $14.50 for No. 1 Foundry; $12.50 to $13.50 for No. 2, and $11.75 to $12.50 for Gray Forge.

Antimony—The market is steady. We quote L. X., 10c. to 10.05c.; Cookson's, 10½c. to 10¼c.; Hallett's, 9.70c. to 9¾c., and U. S. French Star, 10¼c.

Copper—The tendency is toward a firmer feeling in the market. Some business has been done at 9¾c. for Lake Copper, but now 10c. is asked, and 9.60c. is still bid without business. Casting Copper is held at 9¼c. to 9⅜c.

Lead—The market is unsteady. Buyers are bidding 3.80c. to 3.80½c., but the sellers are firm at 3.90c. to 4.00c.

Lard Oil—Prime City is quoted at 64c. to 65c.

Spelter—The market is improving. Holders are asking 3.80c. to 3.90c., according to brand, for New York delivery, but the volume of business is light.

Tin—Sellers have advanced their price to 20c. for spot, 20.15c. for September, 20.25c. for October, and 20.60c. for November. On account of the high rates, very little business is done.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Situation by draftsman exp'd in automatic eng. & boiler work. A1 refs. Box 83, AM. MACH.

First-class tool maker and a good draftsman, wants position. Address Box 84, care AM. MACH.

Wanted—Pos'n by mech. draftsman; 7 years' exp. in mach. tools and gen. mach'y. Box 86, AM. MACH.

Draftsman, 4 years' exp. in locomotives, pumps, & Corliss eng., wants pos'n. Box 87, AM. MACH.

Draftsman (mechanical) wishes pos'n on mach'y in general. F. F. Kirpal, 128 W. 61st St., N. Y.

Draftsman & M. E. (grad.) exp'd in hoisting, gen. mach'y & R.R. work, desires pos'n. Box 88, AM. MACH.

Draftsman & M. E. (graduated in Europe) wishes a situation; good refs. Box 78, AM. MACHINIST.

Young man wants position as assistant draftsman. S. B. Field, Roselle, N. J.

Mach. draftsman of prac. exp. wants engagem't; first-class all round man. G. H. R., AM. MACH.

Mech'l draftsm'n, gen'l & power transmitt'g mach. shop practice, wants position. B. B., AM. MACH.

Wanted situation as foreman; engines or dynamos. Address Lathe, AMERICAN MACHINIST.

Mech. draftsman, foreman, 12 yrs.' experience on marine and stationary work desires a change, best ref. from present employers. Box 61, AM. MACH.

Position by draftsman, graduated from Sweden, with 6 years' exp. in machine tools, hydraulic machinery and shaftings. Box 85, AM. MACHINIST.

Competent draftsman, exp'd in automatic high speed engine boilers and gen. mach'y, wants permanent position in east or west. Box 90, AM. MACH.

Wanted—A first-class foundry foreman; one thoroughly acquainted with malleable iron work. Address, giving references. Box 93, AM. MACH.

Experienced designer, familiar with steam and compound engines, hoisting and general machinery, wants position. Box 89, AM. MACHINIST.

A first-class mechanical engineer is open for a permanent position; well up in all kinds of engines and boilers, and keeps his own steam indicator. Samuel Andrews, 56 Trumbull St., Hartford, Conn.

Wanted—By young man, first-class pattern maker and draftsman with drawing room, technical and practical experience, position with firm appreciating nice work. Box 14, AM. MACHINIST.

Wanted—A situation by a machinist and tool maker; well up in fine special machinery and interchangeable tools; capable of taking charge of same. Address Box 92, AMERICAN MACHINIST.

Mech. draftsman and designer having varied exp. on large mach'y with largest mfr's is open for engagement, West preferred; best refs.; full particulars by letter. Adaptable, AMERICAN MACHINIST.

Tool and instrument maker, also fair draftsman, competent to get out jigs and special fixtures, or any kind of experimental work, wishes position or drawing room practice with reliable firm. Address Box 91, AM. MACH.

Wanted—Position as sup't, or foreman, by man skilled as such, in gen. machine shop and foundry, 37 yrs. old, 12 yrs in charge of shops, sober, industrious, thorough mechanic, accustomed to contracting, gen. mach'y, steam plants, familiar with foundry. "A. B. C.," care Whitcomb, Mo.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S. M. York, Clev'd, O.

Best Steel Flue Scrapers. Kelley Co., Erie, Pa.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Rubber, metal and composition patterns for carding & grouping; small rubber & metal work to order. John T. Usher, 116 E. 54th St., New York.

Wanted, To Lease—By a good steady molder of large exp., a small foundry, with an estab'd trade; employing from 4 to 6 men; would buy a foreman's interest in such a foundry. X. X., AM. MACH.

We will pay 50 cents each for copies of the AMERICAN MACHINIST of December 4, 1886 issue, must be unsoiled and in good condition. AMERICAN MACHINIST PUBLISHING COMPANY, 203 Broadway, New York.

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SPECIAL LIST.
Second-hand Machinery.
WILL BE SOLD LOW.

Upright Boring and Turning Mill, 38 in. swing, with Two Heads. A1 order.
Brown & Sharpe's No. 2 Vertical Turret Chucking Machine. A1 order.
Universal Milling Machine. New features.
Lincoln Milling Machine. Good order.
Brown & Sharpe's No. 5 Screw Machine, 1⅜ in. hole, with chasing bar. Good order.
Upright Drill, 40 in., Bk. Gears, Auto. feed. A1 order.
Radial Drill of Extra Weight and Power, 43 in. arm.
National No. 3 Double Bolt Cutter, with Dies. Good.
Engine Lathe, 12 in. x 6 ft., complete. Good order.
" " 16 " x 6 " New Haven, complete.
" " 18 " x 10 " Hendey, cpd. rest, cross feed and ck. A1 order.
" " 20 " x 7 ft., N. Y. S. Eng. Co., complete with chuck. Good order.
" " 20 " x 8 ft., Heavy pattern, with chuck and cross fd. A1 order.
" " 20 " x 12 ft., with cpd. rest, cross fd., "Putnam." Good as new.
" " 22 " x 16 ft., Heavy modern style, cpd. rest and cross fd. A1 order.
" " 24 " x 12 ft., Putnam. Good order.
Planers, 22 in. x 5 ft.; 24 in. x 6 ft.; 24 in. x 8 ft.; 30 in. x 8 and 10 ft.; 36 in. x 8 ft. Good order.
Shapers, 6, 8, 9, 12, 15 and 22 in. stroke.
Boiler Bending Rolls, "Improved Style," 8 and 10 ft.

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SUCCESSOR TO
E. P. BULLARD'S
N.Y. Mach'y Warerooms.
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WE ARE OFFERING
BARGAINS
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Engine Lathes, from 14" to 48" swing.
Hand Lathes, from 10" to 20" swing.
Planers, from 24"x5' to 42"x12'.
Shapers, from 15" to 20" stroke.
Drill Presses, all sizes up to 24" swing.
Milling Machines, Plain and Universal.
Brown & Sharpe Screw Machines.
1 Large Newton Slotting Machine.
1 Large Pond Mach. Tool Co.'s Radial Drill Press.
3 Gould & Eberhardt Automatic Gear Cutters, 36", 48", and 60".
1 Betts Machine Co. large Horizontal Boring Mill.
2 Large Bliss Power Presses.
1-10 H. P. Baxter Engine, with 15 H. P. Boiler, complete, as good as new.
Also, Tool Grinders, Die Sinkers, Tapping Machines, Bolt Cutters, and large Pattern and Blacksmith Shop Equipments.
These tools are in good order and of the very best makes in this country. They will be sold at remarkably low prices
Call at our salesroom and inspect them, or write for complete descriptive circular and price list.
THE GARVIN MACHINE CO.,
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FOR SALE.
Second-hand 36-inch Eberhardt's Patent Automatic Gear Cutters, for cutting **SPUR GEARS** only, also for cutting Spur, Bevel and Worm Gears. All in A1 condition, being rebuilt at our own Works. These were taken in exchange for our new type. Also No. 3 Baker Blower, good condition, only little used, and one second-hand 36-inch Full Brainard Gear Cutter, good condition, and a bargain. Photos and full information write to
GOULD & EBERHARDT, Newark, N. J.

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SOLE MANUFACTURERS OF
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Endorsed by Practical Mechanics Everywhere. Send for Catalogue.

Second-Hand and New Machinery.

Planers.	62 in x22 ft.	Planers.	25 in.x5 ft.
"	42 in.x16 ft.	"	24 in x5&6 ft.
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"	26 in.x7 ft.	"	22 in.x5 ft.

80 in. x 20 ft. Engine Lathe Triple Geared
80 in.x18 ft. Engine Lathe Geared Face Plate.
52 in.x35 ft. Engine Lathe Horizontal Boring Machine, one end.
36 in.x16 ft Engine Lathe
33 in.x27 ft. " "
32 in.x12, 14, 16, 18 ft. Bed. New Engine Lathe.
28 in.x22 ft. Engine Lathe, cheap.
25 in.x12, 16, 20 and 24 ft. Bed. New do do
24 in.x10, 12 ft. Bed. do do do
20 in.x 5 6, 8 & 12 ft. do 2d Hand do do
18 in.x 6, 7 & 8 ft. do New & do do do
17 in.x 8 ft. do do do do
16 in.x6 & 8 ft. do do do do do
15 in.x 6 & 8 ft. do do do do do
Car Axle Lathe, Bement. | Driving Wheel Lathe 88 in.
15, 16, 18, 25 in. Crank Shapers. | Wheel Quartering Mach.,
20, 24, 26 & 30 in. Geared Shapers. Double right and left hand.
20, 22, 24, 28, 30 & 36 in. Drills. | No. 0 Turret Lathe,
Bolt Cutters. | Am. Tool and Mach. Co.,
8 and 10 in. Stroke Slotters. | 24 in. Swing, 8 ft. Bed.
Lot of Lincoln Pattern Millers and No. 1 P. & W. Millers.
2 Spindle Drills. Garvin.
No. 12 Turret Lathe J and L. 3¼ hole.
1100 and 3000 lb. Bement Steam Hammer.
100 lb. Steam Hammer. | SEND FOR MAY LIST.
40 H. P. Vert. Engine. N. Y. S. S. P. Co.
16 in.x48 in. Brown Eng
300 H. P. Westinghouse Comp'd Engine.

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From large Machine Shops having Pattern Shop to build Press weighing about 2,000 pounds. Working drawings and full particulars on application.
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TELEPHONE 4,180.

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A SPLENDID 16-INCH LEVER DRILL
CAT. NO. 8. AT VERY LOW PRICE.

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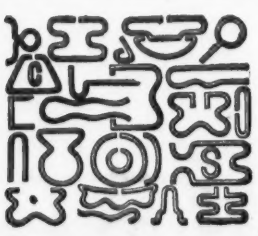
EICKEN & CO.'S CRUCIBLE TOOL STEEL
HAGEN, WESTPHALIA, GERMANY.
SPECIAL No. 8, makes a fine finish on the hardest Rolls; Boss Cold Chisel Steel; High Grade Twist Drill, Tap, Punch, Reamer, Wood and Milling Cutter Steel and Blanks.
The **HIGHEST QUALITY**; Inducements to the Trade and large Users.
REPRESENTED BY EDW'D VORSTER. } **IMPORTERS & EXPORTERS.** { MARKT & CO., Agts. 79-85 N. Moore St., New York.



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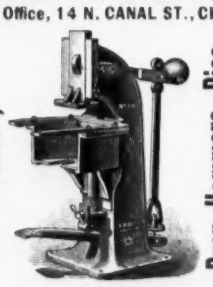
Builders of WIRE FORMING MACHINES
With F. B. Manville's Patent Sliding Former,
For making articles from the coil, of either round, half-round, flat, or square wire, similar in shape to those shown in the cut herewith. Also similar articles made to order.
Send samples of articles required, and mention quantity wanted, that we may quote prices for either machine or the goods, whichever may be desired.
☞ **Bicycle and Labor Saving Machinery a Specialty.**

WE LEAD, OTHERS TRY TO FOLLOW.
If it is not true that we are building **THE BEST BLOWER** now on the market, why this haste on the part of others to discard methods of construction long considered by them as good enough, and why their efforts to imitate our new ideas?
When you require a positive blast and want something efficient and economical, write to
THE CONNERSVILLE BLOWER CO.,
CONNERSVILLE, IND.

E. W. BLISS CO.,
1 ADAMS ST., BROOKLYN, N. Y.
Western Office, 14 N. CANAL ST., CHICAGO, ILL.



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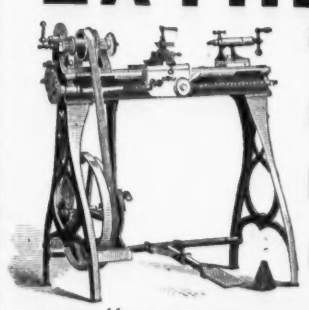
When in Chicago call at our Exhibit, Section 28, Machinery Hall Annex.

LATHES



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Book on Gears, 170 Illustrations, $1.00. Job Gear Cutting of all kinds. Spur, Bevel, Spiral, Ratchet, Worm-Rack, Elliptic, Index Plates, Noiseless Fiberoid Gears, etc. Very small or large. Send for Catalogue. 1100 sizes of Gears.

PUNCHING AND POWER PRESSES.
11 SIZES. LOW PRICES.

Bench Straightening Press.....	$40.00
No. 1 Arbor Press.....	15.00
No. 2 Arbor Press.....	25.00
Bench Shear and Rod Cutter.....	20.00
Bench Punch, ¼ Cutter	20.00

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THE SPRINGFIELD MACHINE TOOL CO.,
SPRINGFIELD, OHIO.

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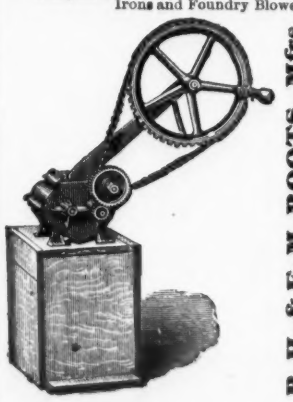

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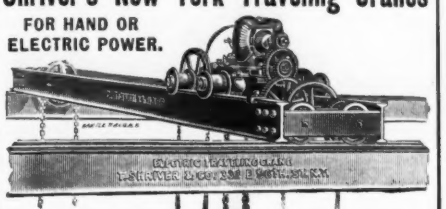
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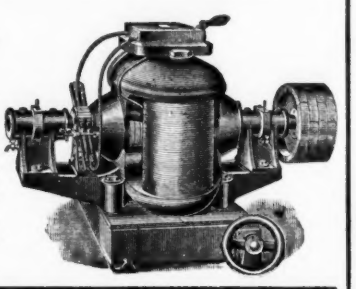

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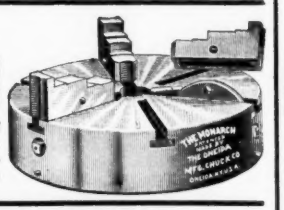
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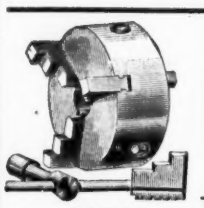
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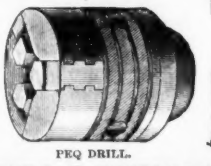
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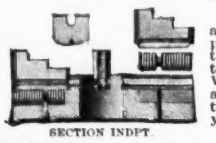
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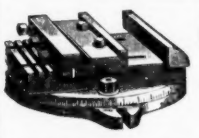
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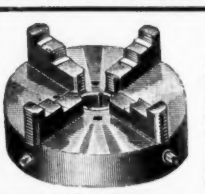
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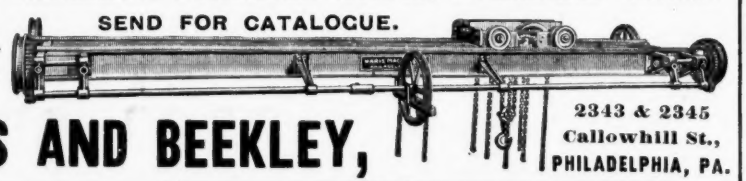
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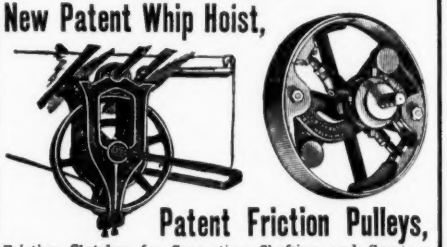
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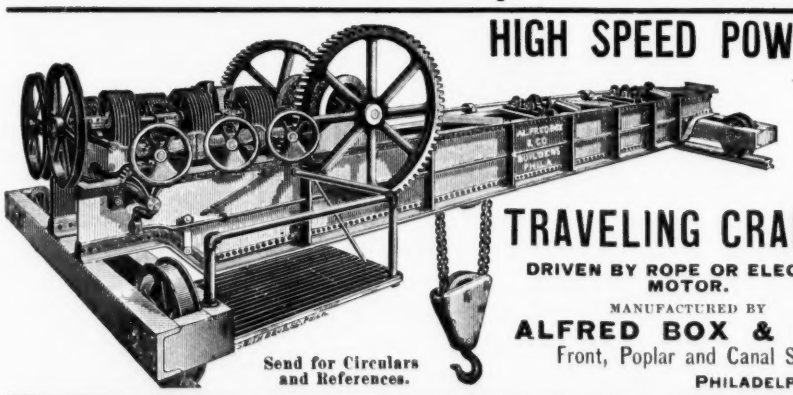
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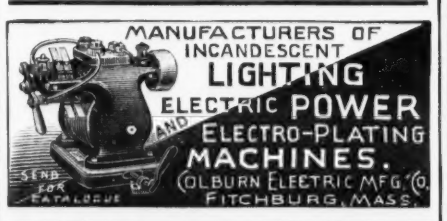
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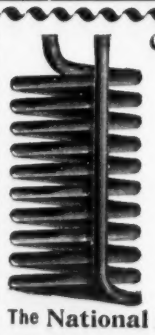
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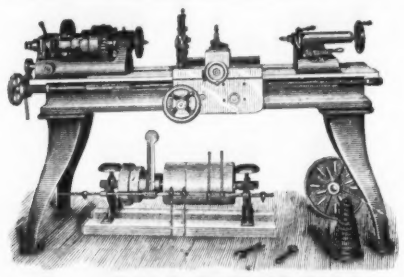

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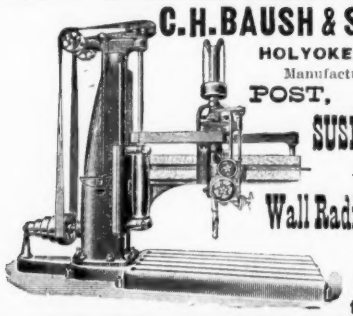

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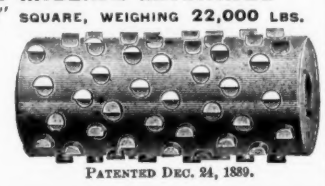

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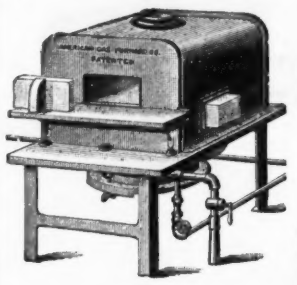

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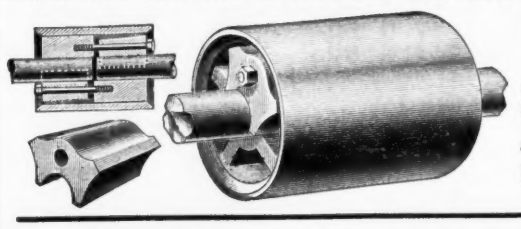

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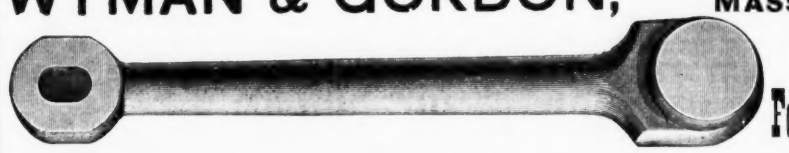

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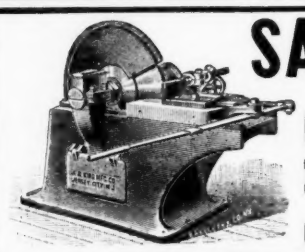

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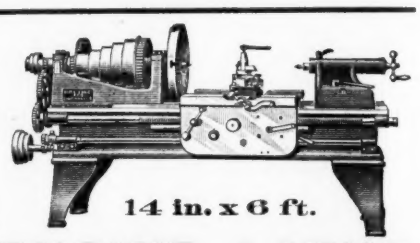

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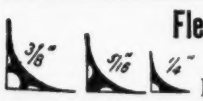

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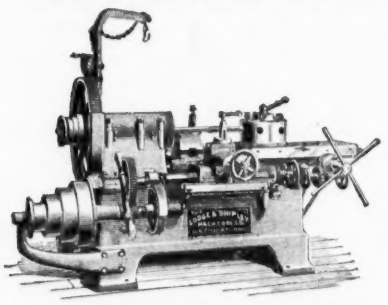

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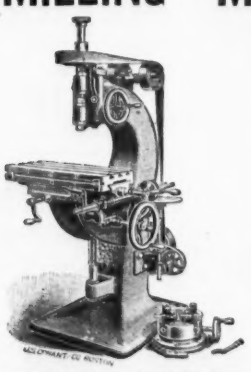

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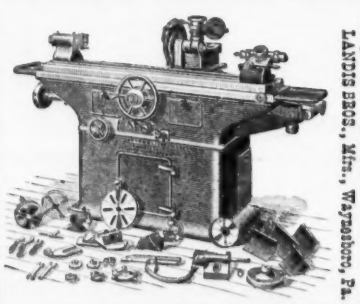

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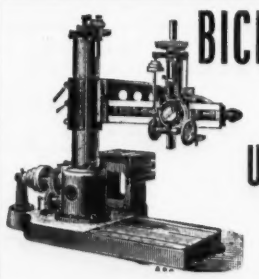

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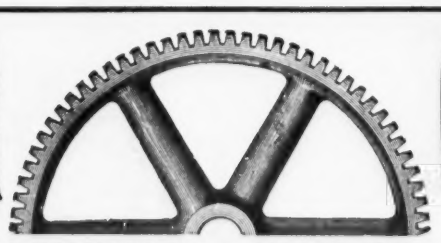

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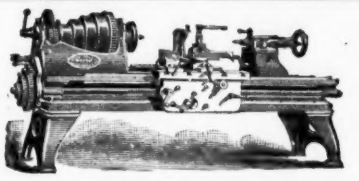

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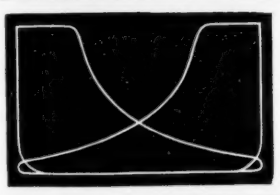

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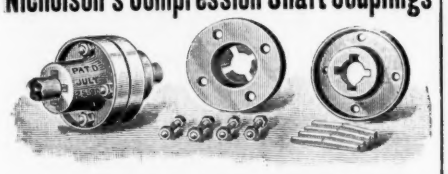

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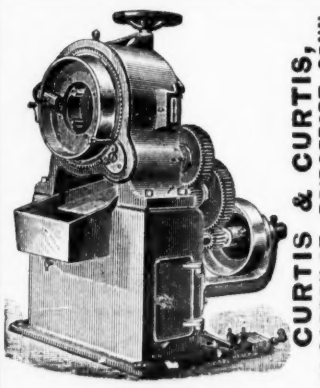

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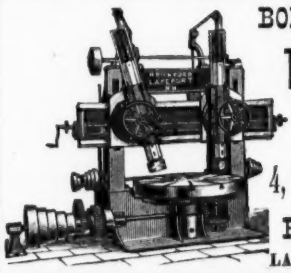

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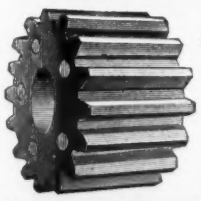

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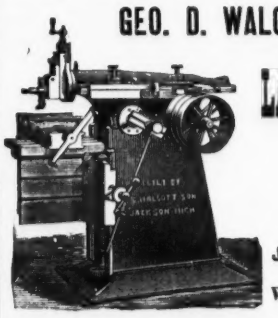

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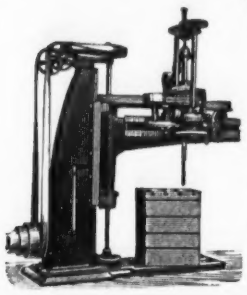

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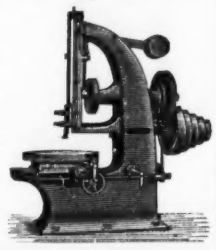

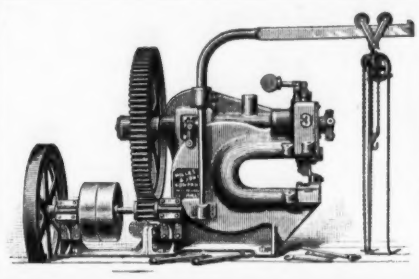

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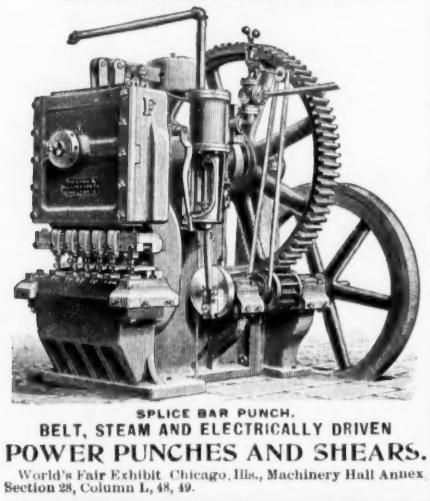

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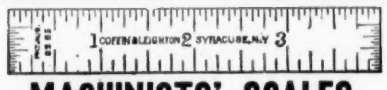

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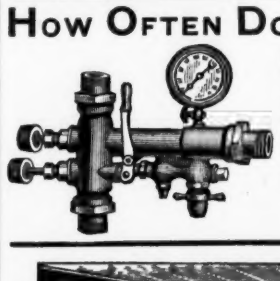

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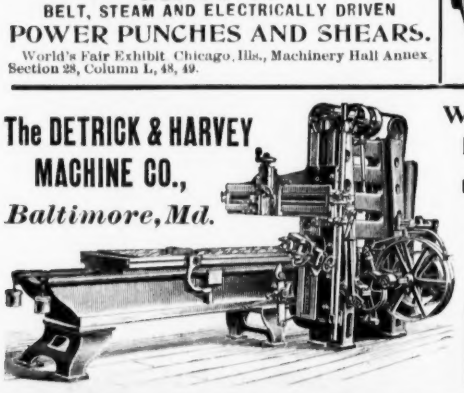

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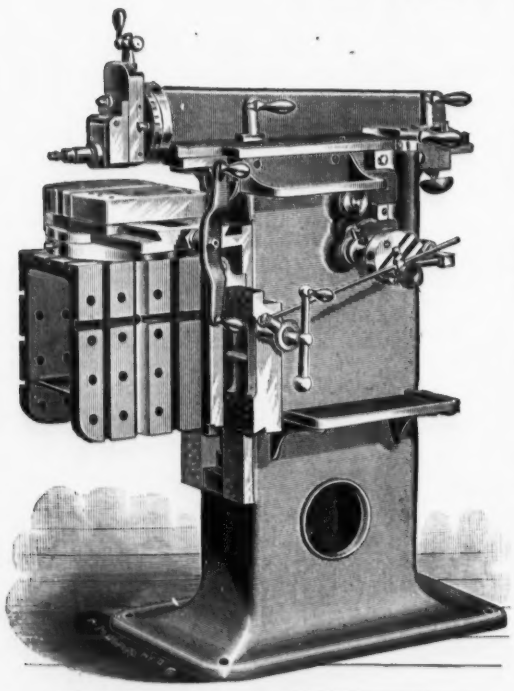

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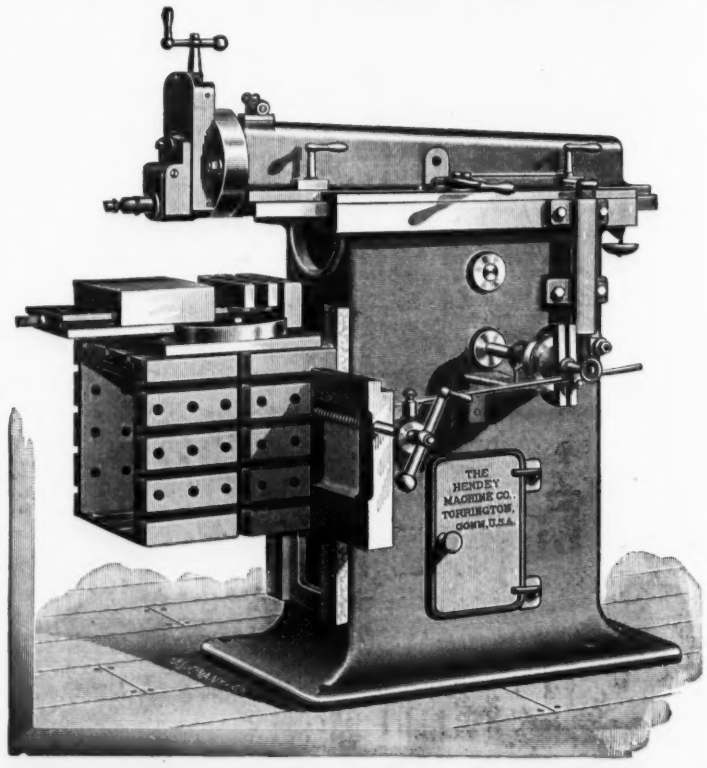

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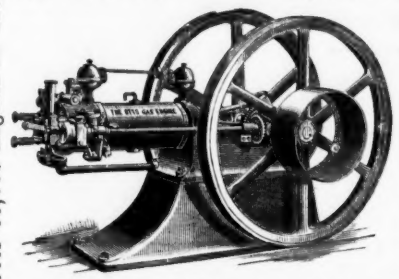

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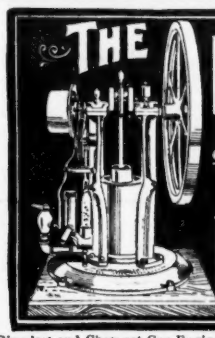

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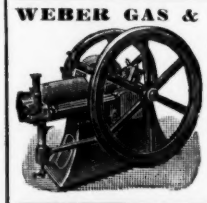

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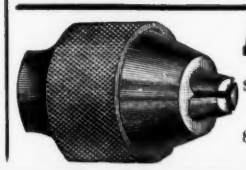

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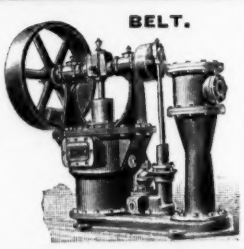

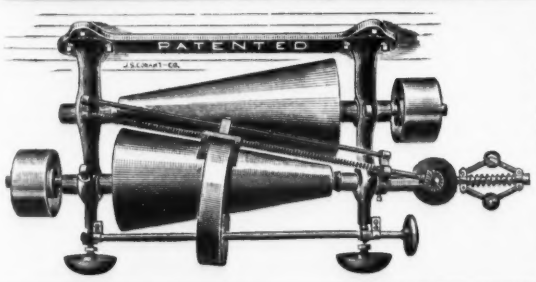

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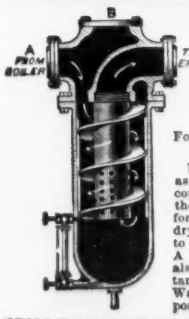

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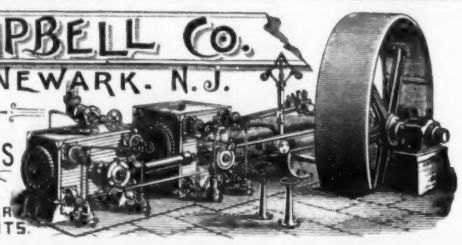

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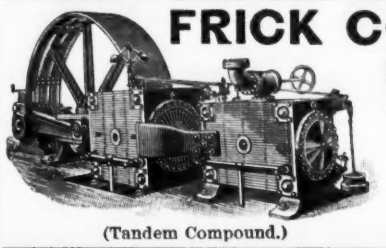

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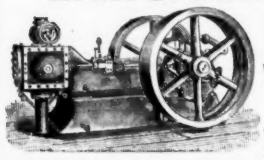

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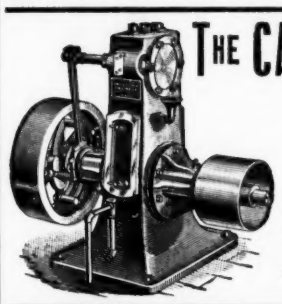

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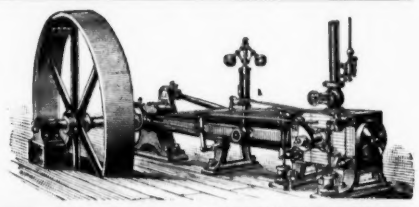

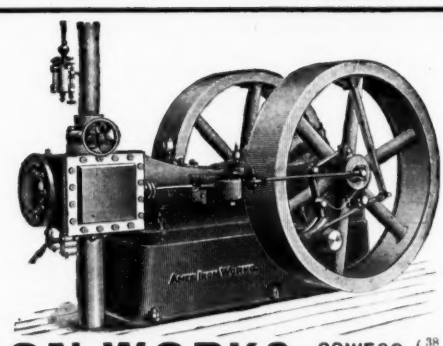

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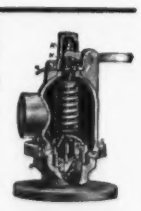

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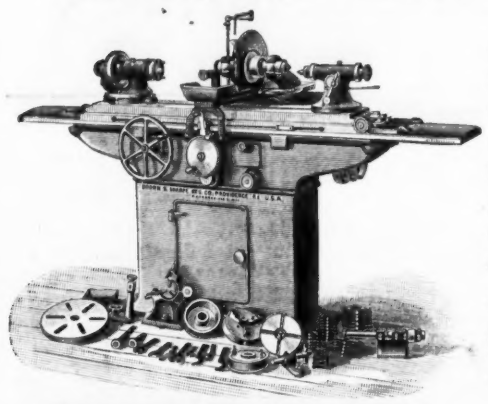

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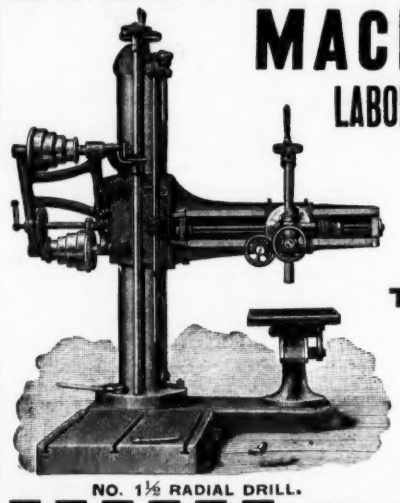

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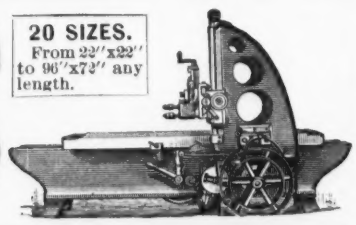

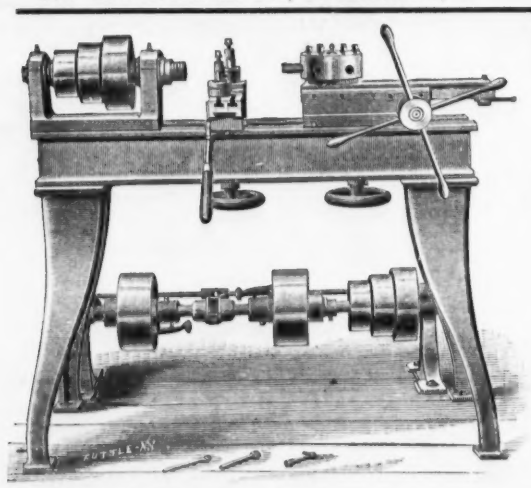

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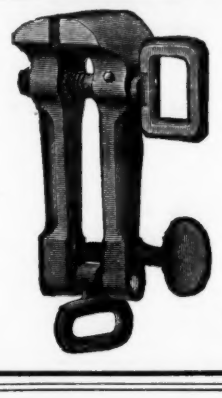

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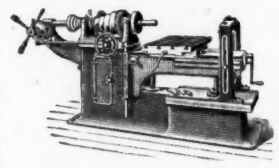

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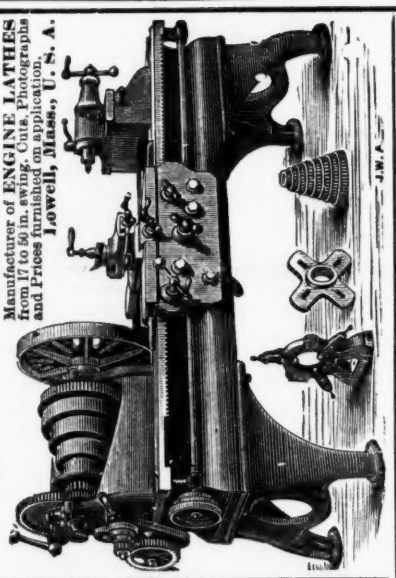

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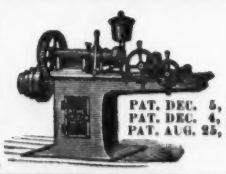

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